APRIL 2006

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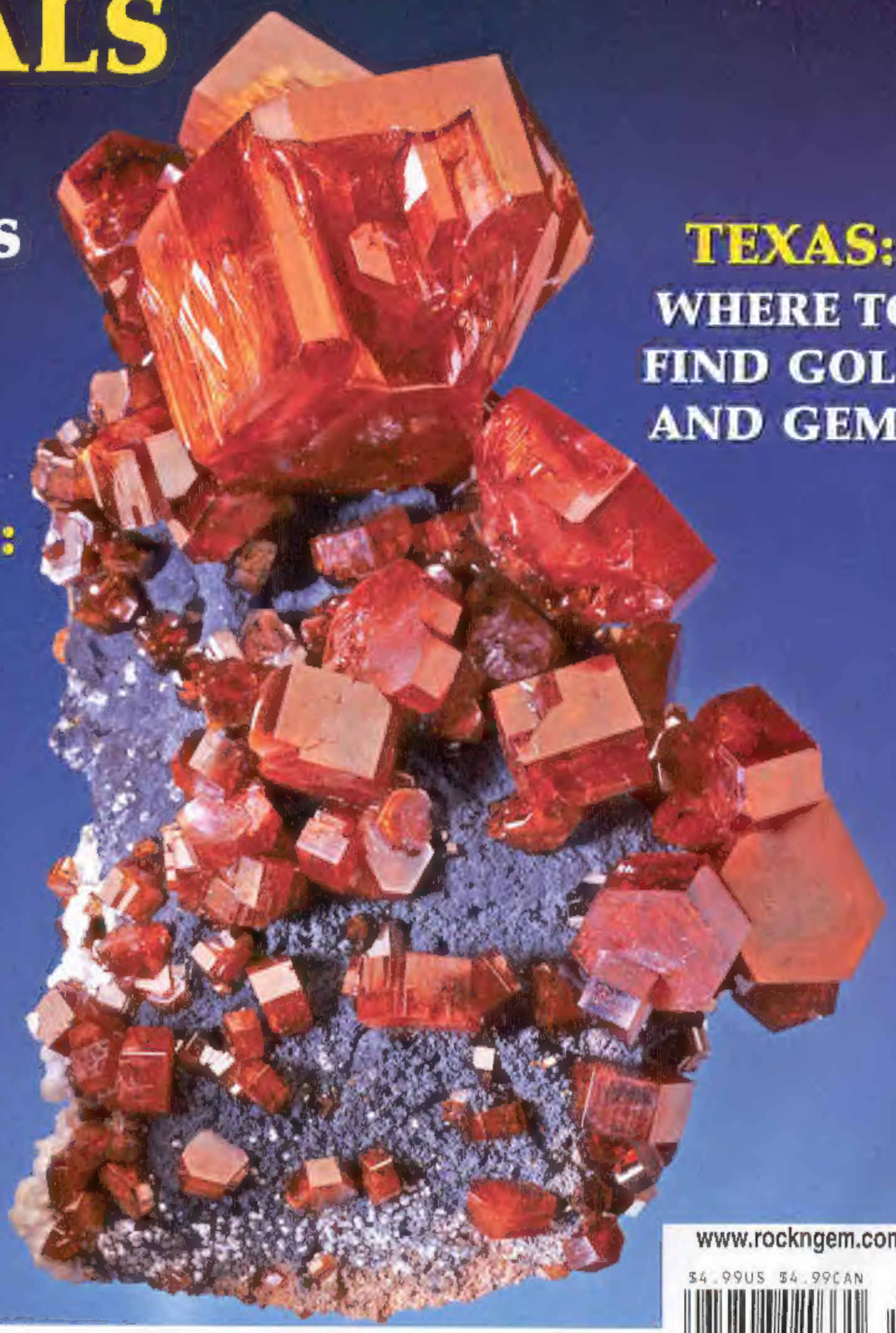
Panning Montana Gold

SHAPE-SHIFTING MINERALS

The Amazing Pseudomorphs



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Vanadinite is a popular vanadate collector mineral. This 8.4-centimeter-high specimen from Mibladen, Morocco, is in the Steve Smale collection. (Photo by Jeff Scovil)

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Mineral Pseudomorphs

There's More to These Specimens than Meets the Eye

Story and Photos by Bob Jones

Most of the minerals in your collection are exactly what they seem to be. But hidden among the quartzes and pyrites, the wulfenites and coppers are minerals in disguise, minerals that cloak themselves in the form and shape of others. We call these duplicitous minerals pseudomorphs; the word comes from the Greek "morphe," meaning "shape," and "pseudos," meaning "false." In special cases, we use the terms paramorph and cast.

Paramorphs are minerals that, once they have formed, change their internal crystal structure so that they become a new mineral. Calcite and aragonite can do that since they are the same chemically, but differ in crystal structure. The problem with paramorphs is that you can't visually detect any change. All you can see is the form of the original mineral. The changes are internal.

You might think of casts as hollow pseudomorphs. A mineral crystal forms, then is overlain by a more resistant mineral. Later solutions dissolve away the first mineral, leaving that second one in the crystal shape of the first.

Whether you are looking at a pseudomorph, paramorph or cast, you see a mineral that has taken the shape or form of another mineral. You might think of it as fossil evidence of an earlier mineral. After all, plant and animal fossils are frequently pseudomorphed, usually by quartz, after the original living thing.

When we describe pseudomorphs, we express them as quartz after wood, calcite after aragonite, or pyrite after trilobite, the operative word being "after."

In mineralogy, a true pseudomorph develops when one mineral takes the

This fortification agate pseudomorph after dinosaur bone is a real rarity.

EVAN JONES COLLECTION

Some of this azurite has pseudomorphed into malachite, making a nice color contrast.

crystal form of another. Weathering or a change in its environment can partially or completely alter a crystal to another mineral.

A good example is the copper carbonate azurite. Each molecule within its crystal structure consists of three atoms of copper, two molecules of carbon dioxide, and two molecules of the hydroxyl radical (OH). Azurite is a bit unstable, and under the right conditions it begins to lose atoms, which changes its chemistry, but not its outward crystal form. The end result is that the azurite no longer exists; it has been replaced, or pseudomorphed, usually by malachite. It simply looks like green azurite!

In thin azurite blades with a lovely malachite tip or a rosette smack in the middle of the azurite prism face, the blue azurite has become green malachite because the internal chemistry has altered. When you compare the azurite molecule with the malachite molecule, you can see what happens.

Malachite molecules are made up of only two atoms of copper, one molecule of carbon dioxide, and two hydroxyl molecules. If a crystal starts as azurite and loses one copper atom and one carbon dioxide molecule, it can no longer be azurite. Instead, it has taken on the chemistry of malachite. The original azurite crystal form remains the same, but there is a dramatic change of color from blue to green. The volume occupied by the original azurite is reduced slightly, so many malachite crystals pseudomorphed after azurite have slightly concave faces or may even show some cracking or shrinkage. Malachite after azurite is quite common anywhere azurite forms.

We've already indicated there are mineral pseudomorphs after organic material. When such a piece of wood gets buried under the right conditions, it will slowly be dissolved by weathering. Minerals in the invading water take the place of the

A.E. SEAMAN MUSEUM COLLECTION

Native copper from the Keweenaw Peninsula in Michigan forms casts after quartz crystals.

wood molecule by molecule. If the replacing mineral is quartz, we end up with a piece of petrified wood. It looks like wood and is shaped like wood, but it is really a solid piece of quartz in the form of the original wood. The piece may still be cloaked in what looks like bark and the original tree rings are often preserved, but the wood is now a quartz pseudomorph after wood. If the replacing mineral is precious opal, the results can be astounding!

At a mineral show, you'll find plenty of examples of one mineral replacing another. Some of the more common mineral pseudomorphs make a wonderful collection or suite within your collection. Some advanced collectors actually specialize in assembling a fine pseudomorph collection.

Most pseudomorphs are readily identified, but paramorphs are impossible to identify by sight. The mineral's chemistry remains the same, but its internal crystal structure has changed due to outside influences like temperature changes.

Probably the most common textbook examples are the silver minerals acanthite and argentite. Chemically, both are silver sulfide; one molecule of two silver atoms linked to one atom of sulfur makes the silver sulfide molecule, which builds the argentite and acanthite structure. So how can one mineral, without changing its chemistry, become another mineral? The answer is, a change in crystal form.

continued on next page

EVAN JONES COLLECTION

Greasy chrysocolla has completely replaced the original azurites in this Inspiration, Arizona, specimen.

Mineral Pseudomorphs *from page 13*

Argentite forms in the isometric, or cubic, system at temperatures above 179 degrees Centigrade because it takes lots of energy to maintain that form. Above that temperature, the molecules arrange their structure so that the external shape of argentite is a cube or a variation of the cubic form (an octahedron or dodecahedron).

Argentite seldom remains in an environment well above the boiling point of water. As the temperature drops, the molecules of silver sulfide get restless and can't hold their position. They begin to shift around as the electrons lose energy and move into positions that require less energy. The resulting internal structure is no longer cubic, but orthorhombic. The external shape remains cubic, but if you were to X-ray the crystal, you'd see that the internal structure is no longer cubic. To acknowledge this change from cubic to orthorhombic, we give the mineral a new name, acanthite. If you own a silver sulfide specimen that is labeled argentite, you'd better change the label to acanthite unless you are keeping your mineral cabinet above 179 degrees Centigrade.

Mineral casts are easy to describe. After a mineral forms, a solution rich in another mineral may engulf it and deposit the second mineral on the first. The mineral coating takes the shape of the original mineral, though it may have a different chemistry and crystal form. If nothing else happens, we refer to this as epitaxial growth, in which the second mineral's positioning is influenced by the mineral crystal upon which it formed. This is quite a common occurrence in the mineral world.

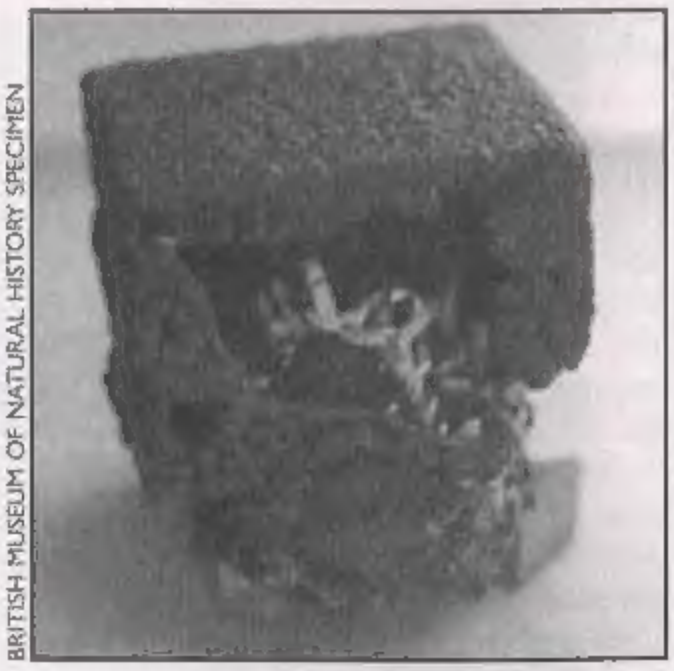
Casts develop when a later solution dissolves away the first mineral. A very common example of this is the mineral fluorite, which is easily coated with a mineral like quartz, calcite, or an iron carbonate. A third solution dissolves away the fluorite, and the second mineral coating is left untouched. The result is a cast, what we earlier called a hollow pseudomorph.

The lead/zinc mines of Kansas, Missouri and Oklahoma, better known as the Tri-State region, produced fine galenas and sphalerite crystals in abundance. Equally abundant were dogtooth calcite crystals.

As weathering occurred, the sphalerite sometimes broke down, releasing zinc atoms. These combined with carbonate radicals or silica to form smithsonite or hemimorphite. On rare occasion, these secondary minerals have been found as casts after the original calcite. Similar hemimorphite casts after calcite have been found in the Yellville lead mines of Arkansas.

Fine examples of fluorite from the gold mines of the San Juan Mountains in Colorado are common. On rare occasion, delicate white quartz casts after fluorite have been found in fair abundance. The fluorites tend to be simple cubes up to an inch or so on an edge. After finely crystalline white quartz formed a complete covering over the crystal, the fluorite was etched away, leaving the white quartz cast. Sometimes, the quartz failed to completely cover the fluorite crystal, so you can actually peer inside the hollow cast. They are particularly fragile.

In the San Juan Mountains, calcite, particularly scalenohedron crystals, has also been coated with quartz, then dissolved away to leave quartz casts after calcite.



BRITISH MUSEUM OF NATURAL HISTORY SPECIMEN

This siderite cast of a 4-inch fluorite crystal grew a chalcopyrite cluster topped by white quartz.

The best-known and rarest casts ever found during mining came from a wonderful old iron mine called the Virtuous Lady Mine, in Tavistock, Devonshire, over 150 years ago. The best known is a siderite cast of a large fluorite cube. The small, rounded, intergrown siderite crystals covered the fluorite, save for a small window on the crystal's side. The very best of these pseudomorphs after fluorite began as a fluorite crystal measuring 4 inches on an edge. This amazing specimen is in the British Museum of Natural History.

What makes this specimen extra special is that after the fluorite was etched away, several fine chalcopyrite crystals grew right inside the siderite cast! As if that were not enough, Mother Nature decided to decorate the brassy chalcopyrites with snow-white quartz crystals. The entire specimen is quite an amazing assemblage of species, and certainly one of the finest examples of a cast ever found.

The Virtuous Lady Mine has also produced another type of siderite cast called Lady Slippers. These are flat-pointed casts of what have been judged to be relatively thin, flat barite crystals.

Not all pseudomorphs consist of secondary minerals. Some of the replacing minerals are what we consider primary minerals. The variety of species that can create a pseudomorph is quite remarkable, even including sulfide minerals. The iron sulfide pyrite is a particularly common replacing mineral; it takes the place of fossils like ammonites, trilobites and clamshells. It can also replace a mineral like pyrrhotite.

Some pseudomorphs are so rare that only a handful of examples exist. Still others are found in great abundance, almost too numerous to count. The most common mineral pseudomorph found on Earth is what we call limonite after pyrite. "Limonite" has long been used to identify what we now know is a group of hydrous iron oxide minerals. In truth, there is no such mineral. General agreement is that what we call limonite is largely the mineral goethite, though lepidochroite and other hydrous iron minerals may also be present. Limonite after pyrite is found at dozens of sites around the world.

Pyrite is iron sulfide, with one iron atom and two sulfur atoms per molecule. Limonite (goethite) is usually an atom of iron and an atom of oxygen coupled with the hydroxyl radical. As pyrite forms, it traps extra sulfur atoms or other impurities into its structure, making it very susceptible to breakdown during weathering.

Over time, some of the extra sulfur in pyrite can combine with water to form a weak acid, and this speeds the breakdown of the pyrite. Oxygen and the hydroxyl radical in water join with the iron atoms to create goethite or other similar secondary iron minerals. The original pyrite crystal form remains unchanged; a goethite or limonite after pyrite looks as if the brassy pyrite has simply changed color to a chocolate brown. Of course, goethite is much softer, but in other respects, it mimics the pyrite right down to the striations on the crystal faces. Even the original cracks in the pyrite may be preserved faithfully in the pseudomorph.

Here in the United States, the finest examples of limonite after pyrite have come from Pelican Point at Utah Lake, in Utah County, Utah. Wonderfully sharp single crystals and clusters of crystals have been found here for decades. The crystals are sharp, still striated à la pyrite, and a deep mahogany to chocolate brown color.

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Mineral Pseudomorphs *from page 15*

Crystals of goethite after pyrite have been found at several places in Pennsylvania, including Fruitville (Lancaster County) and near York (York County). The crystals are usually found loose and, again, are perfectly preserved pyrite images. Here in Arizona, you can wander the desert south of Aguila and Salome and find small, sharp limonite after pyrite cubes scattered on the desert floor.

In Europe, limonite after pyrite is not common, but one locality, better known for superbly crystallized pyritohedral pyrites and bladed hematite, is Elba, Italy. Remarkable limonite after pyrite crystal groups that rival the Pelican Point clusters are found here.

Pyrite pseudomorphs after a variety of fossils are found in Germany, England and France. Of these, Lyme Regis, along the southern coast of England, is probably the best known fossil site, and certainly the most important historically. The original small fossils here are ammonites, those coiled, ridged shells that are in the octopus genealogy. They have been replaced by pyrite and are found in the limestone.

Lyme Regis is far better known for the amazing ichthyosaur fossils that were found here. There is even a lovely small museum in the town of Lyme Regis dedicated to these local fossils. The first ichthyosaur fossil was found here by Mary Anning, who described it over 150 years ago. Virtually all fossils are really pseudomorphs in that the original bones have long since been replaced by minerals.

Germany's best-known limonite fossil pseudomorphs are from Wissenbach, Rhineland, where ammonites and other shells are found replaced by this hydrous iron oxide. Certainly, the more exciting fossil replacements are those in which pyrite replaces the original shell. Absolutely lovely, bright, brassy pyrite after ammonites have been found in the Ohio limestones and are much sought. Similar pyrite after ammonites comes from Nurtengem, Germany.

Pyrite is not the only iron sulfide that replaces organic life. Marcasite, a dimorph of pyrite, will also replace wood, ammonites and shells. In the tin mines at Llallagua, Bolivia, marcasite replaced pyrrhotite, yet another iron sulfide.

Pyrite is also very active in replacing minerals. From the classic metal mine at Trepca, Yugoslavia, came superb pyrrhotite crystals, lovely, brassy, hexagonal, tapering crystals in nice diverging clusters. Many are really pyrite after pyrrhotite. This is readily understandable when comparing the chemistry of the two minerals.

Pyrite is iron sulfide, but so is pyrrhotite! The difference is that a pyrite molecule always has one iron and two sulfur atoms and develops a cubic form. Pyrrhotite, normally a monoclinic crystal, has gaps within its atomic structure that should contain iron atoms. In pyrrhotite's chemical formula, the symbol for iron is written with a minus sign after it (Fe-) to indicate this. If iron atoms later move into those sites, the pyrrhotite ends up being pyrite, even though the familiar cubic shape of pyrite is not evident. So a pyrrhotite crystal and a pyrite crystal will have different shapes, but both are brassy yellow, and the pyrrhotite could very well be pyrite. Pyrrhotite can become a true pseudomorph—pyrite after pyrrhotite—even though it has retained its original pseudohexagonal shape.

Pyrite frequently replaced organic material, such as in this fossil ammonite from Germany.

Some of the nicer pyrite after pyrrhotite pseudomorphs have come from Santa Eulalia, near Chihuahua City, Mexico. On one of our Arizona-Sonora Desert Museum research trips into Mexico, we stopped in Santa Eulalia on our day off to see if there were any minerals for sale. Luckily for us, one miner took us into his dimly lit bedroom and pulled a flat of wonderful pyrrhotites from under the bed. The crystals are classic pyrrhotite: pseudohexagonal, tapering to a point, and curving along the long axis, a trait typical of elongate pyrrhotite crystals. The brassy crystals were free standing on a black sphalerite crystal matrix. The longer crystals were over 4 inches in length. Luckily, I was able to obtain a couple of these beauties. Later investigation showed these very showy groups were no longer pyrrhotite at all, but were pyrite after pyrrhotite, making these specimens a doubly lucky buy.

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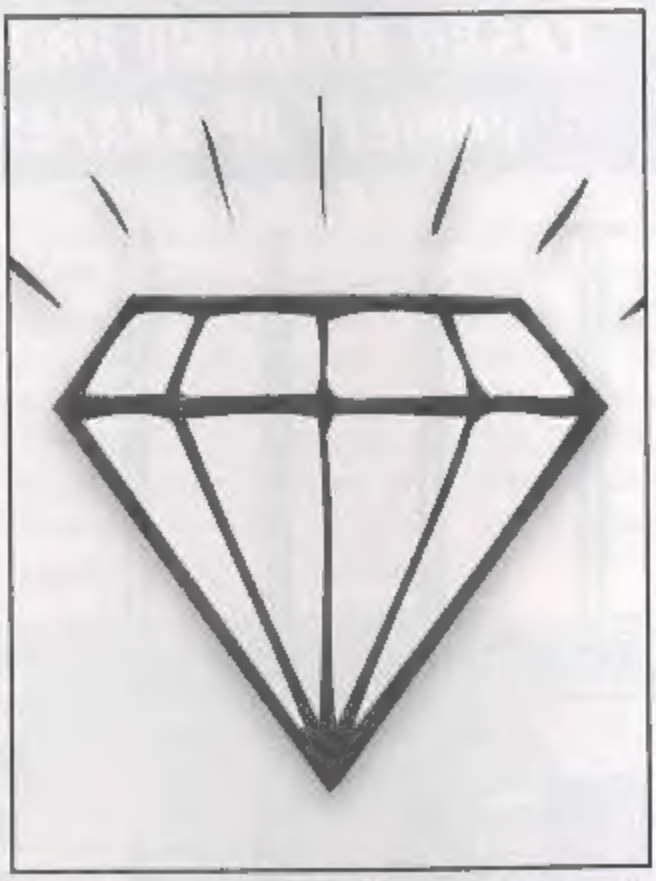
Shop Talk

William A. Kappele

Getting the Perfect Polish

I titled this column knowing full well that many of you out there in Readerland would let out a harrumph and think things like, "If he can get a perfect polish, why isn't he out putting perfect polishes on gemstones for juried shows instead of just talking about it?" Of course, I would be doing just that, and no, I am not a perfect polisher. But even if I don't achieve a perfect polish on my cabs, I know how it is supposed to be done, and I'll bet I can offer some tips to some of you that will at least help you to get closer to the perfect polish than you are now.

This idea started when I heard from a reader who was having trouble getting a polish that pleased him. This problem isn't unique; most of us hit that wall. But he was having the same trouble with both cabs and tumbling. This immediately raised a red flag. In my experience and in the experience of virtually all with whom I have spoken on the subject, the polishing step is not the culprit in unsatisfactory polishes. Rather, the culprit is almost always one or more of the steps leading up to it. Remember that from preform to finished gem, the process is one of imparting finer and finer scratches on the stone. I once had someone write and tell me that if I had sense enough not to scratch the stone in the first place, I wouldn't have to work so hard to get rid of them. Sorry, but if you don't want to put scratches on your stone, then you had better just mount the preform and give it to Aunt Freda.



Now if you are ready to give finding the perfect polish a shot, then here are the steps I think you should follow. If this is for Aunt Freda, and her glasses are thicker than your brother-in-law's head, you are permitted to fudge on a step or two. If, however, you are striving to make your polish as perfect as humanly possible, then follow the steps religiously.

1. Make absolutely certain that your preform is as close to the final shape as possible. Remove as many flats as possible (watch that one in the center). Don't rely on the sanding steps for changes in the shape of the stone.
2. Wash everything thoroughly between each step. Don't let a grain of the previous grit remain on the stone, the dop, your hands, anywhere. A grain of 220 grit in your 600 stage will put a groove that looks like the San Diego Freeway on your stone.
3. Keep your discs, wheels, pads, or whatever you use in plastic containers, Ziploc bags, or something similar to keep them hospital clean.
4. Always be absolutely certain that you have removed all of the scratches from the previous grit before moving on to the next one. (An old trick I still use is to rotate the stone 90 degrees for each step. That way, if you are sanding on the long axis of the cab, you sand until there are no scratches on the short axis, and so on.) Also, if you are in the bifocal or trifocal stage of life, don't be ashamed to use a magnifying glass or a loupe.

If you have followed the steps above, you should be able to use the polish and technique you have been using and get a great polish. It may be your version of perfect, or it may need some fine tuning. If so, you will just have to experiment with different pads, polishes, etc. This is an area that is more art than science, so don't get discouraged. Just keep track of your combinations and lock the one that works best in your safe.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

Field Trips to Old Collections

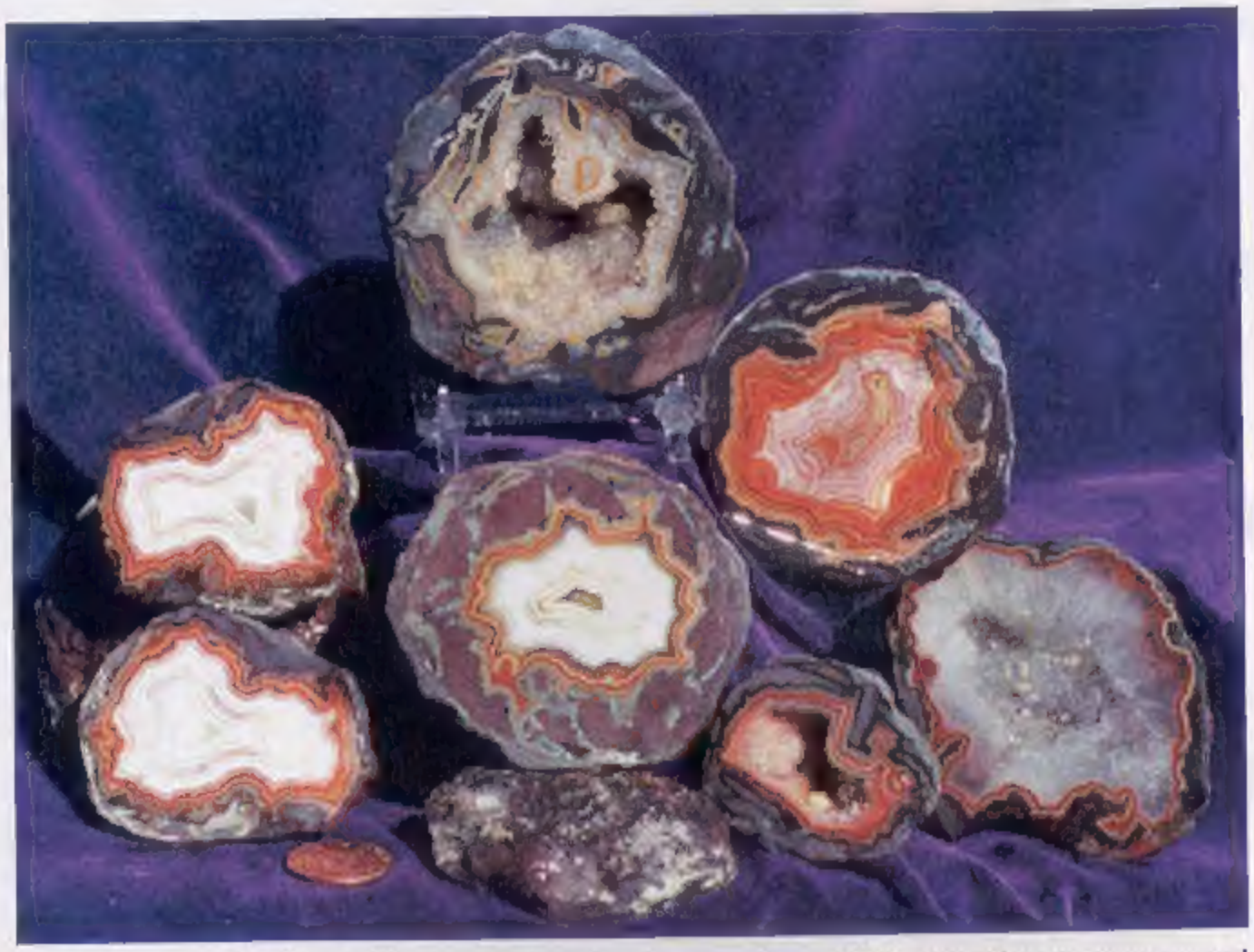
The Hard Work Has Been Done for You

Story and Photos by Curtis L. Handy

While beating about the countryside for rocks has its rewards, much is to be said for trekking to existing collections—the older the better. These rock piles are usually conveniently located in backyards, workshops, barns, and old rock shops. Aside from someone else having done all the digging, pounding and sweating, the material to be found there is often excellent, older rock that may no longer be available for collecting. Disappointments are to be expected, but more often than not, treasures are found. And it's always fun and exciting to dig around and try to identify unlabeled specimens.

Old collections are more numerous than one might expect, especially here in Oregon. It only takes some curiosity to seek them out. Garage sales, newspaper ads, computer listings, rock club members (past and present), and friends and relatives are all sources that can lead to a big find. Several of my finds are the result of a simple question in conversation: "Do you know anyone with an old rock collection?" The answer could provide a good lead. With just a phone call or visit, you could be onto a great find! I've been surprised at the number of rock piles friends and I have located by just putting the word out.

Several years ago, while discussing a hunting trip, a coworker mentioned a rock shop he remembered from years past in the Trail area of Southern Oregon. Several phone calls were required to track down the location of the old shop. I found the shop was gone, but the building was still there as another business. Hoping some rock would still be there, I found the new business name and called the number. And, yes, there was rock, and they would sell some or all. Good news!

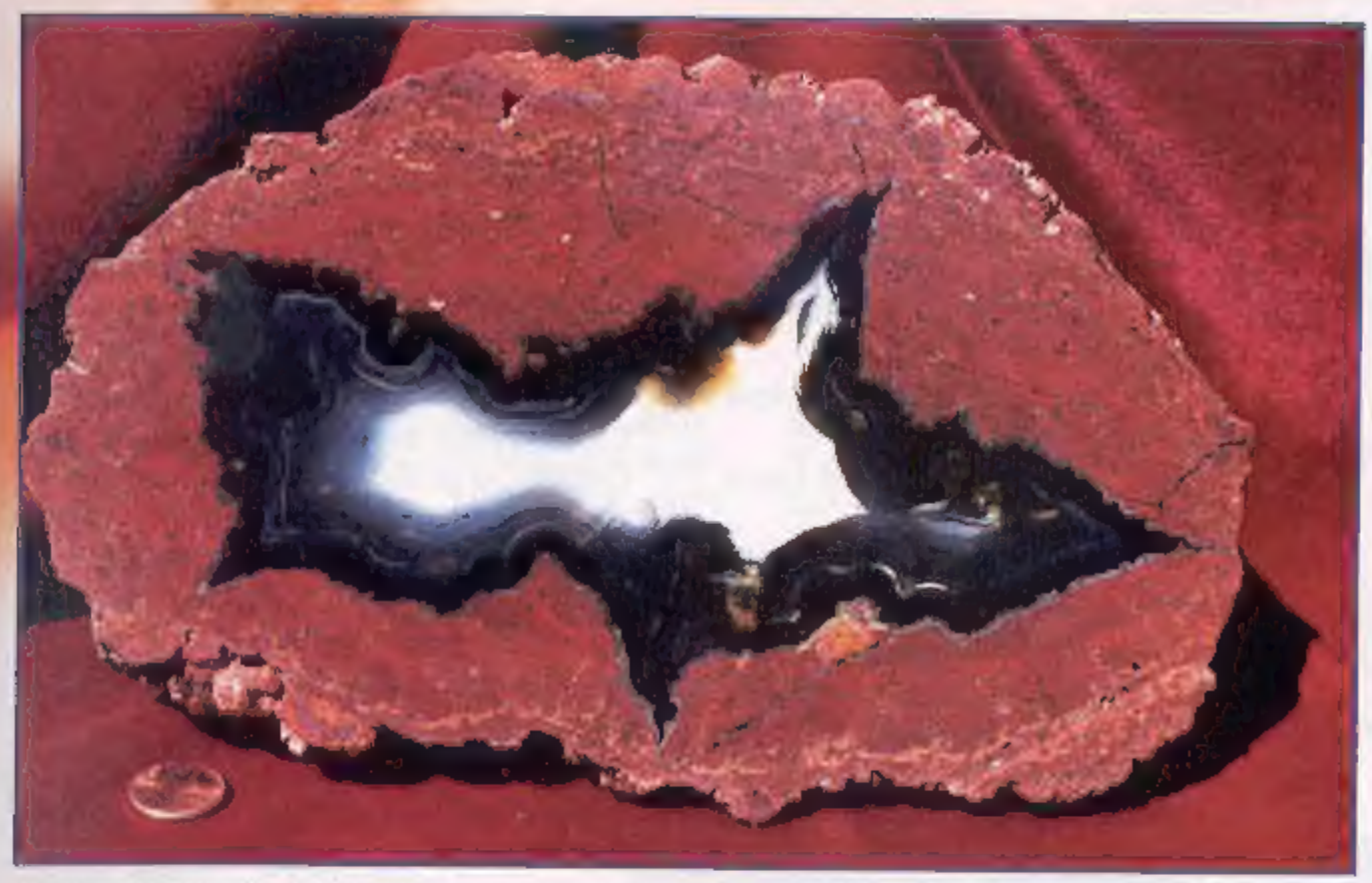


Hard-to-find material like Dry Head agate sometimes turns up in quantity in collections that are several decades old.

So, off I went to Trail, some 100 miles from my home to see—what? "Around back by the river bank, you'll find some piles of rock," the owner said. "Take a look and let me know what you think." I found Arizona wood, septarian nodules, thunder eggs, carnelian, Graveyard Point agate, purple jasp-agate, and various other types of rock. There was some good stuff! I sorted and loaded up some 500 or 600 pounds, paid the man ($125 as I recall), and made the trip back home. I often wonder what the funny-looking egg-sized "stuff" was that I left behind; a treasure, no doubt!

I've since worked up a good amount of what I returned home with. I made several pendants and belt buckles and gave them as gifts. I slabbed other pieces or made them into specimens, with excellent results. I'm glad I took the time and effort to find the old collection and follow through. From time to time, as a piece goes through the saw, pleasant memories of the trip to Trail come to mind.

Some great bargains are to be found when these vintage old collections are found. Often the rock is in the way, needs to be moved, or is no longer of interest to the person or family. In this case, the price per pound or for the lot can be, and usually is, very reasonable. I've paid anything from 5 cents to 50 cents a pound



This beautifully patterned Black Rock Desert thunder egg was hidden in a pile of assorted thunder eggs in an acquired collection.

I used vintage Cherry Creek petrified wood some long-gone rockhound collected from the Elko, Nevada, area in this belt buckle.

over the years. One can expect to pay a little more if one is allowed to pick and choose pieces. Better prices usually result if you buy the whole lot. The average material can often be resold to help defray the initial cost. Fellow rockhounds are usually anxious to dig in and see what they can find.

Fellow rockhounds and club members are, of course, another good source of bargain rock. I'll offer a trade: "How about some of your XYZ rock for some of my ABC stuff?" I have several buckets of this "alphabet" rock. Trading and kibitzing is part of the enjoyment of rockhounding!

The spring of 2004 found several of us visiting the RoxyAnn Rock & Mineral Show in Medford, Oregon. While there, I met a woman who wanted to sell the rock collection she and her late husband had assembled. They had made collecting trips during the 1940s and '50s, so the group of us eagerly made an appointment to meet at her place. Although she had not indicated exactly how much rock there was, she mentioned there was equipment to sell also, which is always worth a look.

At her home, she told us, "The rock is behind that shed," pointing to the back of the property. Wow, what a pile! There were tons and tons of rock. After an inspection, we agreed on a price for the lot. Split four ways, the cost amounted to a few hundred dollars each. It was very reasonable, even though the exact nature of the contents were not known. A big job lay ahead: loading and hauling, then unloading such a large amount. Buckets, pickups, and a large tandem-axle trailer were elected to make the haul.

Loading the tons of rock was quite a project. We decided on a bucket brigade as the best method. With two or three dozen 5-gallon buckets, the four of us set about the task, filling buckets with whatever was in front of us. There was much excitement and curiosity as we dug through the rock. Large and small pieces emerged: limb casts, colorful jaspers, moss agate, petrified wood of many kinds, thunder eggs, obsidian. Some we recognized, and we would call out their names. Others elicited a, "Hey, what's this?" Little rare, famous material, such as Carey Plume, Holley Blue, or Bruneau jasper, was found, but an occasional piece would emerge and spark everyone's interest. And it helped to lessen the work load.

Some of the material was in loose piles, but most filled 55-gallon drum halves. There were also several old 100- and 200-gallon gas drums halves filled to the brim. When they were partially unloaded and light enough, they were tipped over and emptied for easier access. Although at first the amount of material seemed overwhelming, things went along at a good pace. The spring weather was bright and sunny, but as the day wore on, it seemed more like summer.

Each of us managed to put aside a special piece or two. I was able to claim keepers on a bushel box-sized piece of petrified oak, and I squirreled away a nice, round limb section of green Hampton Butte petrified wood. Although the anticipated old icons that could be found on field trips 50 plus years ago weren't found in any quantity, the amount and variety of other notable rock somewhat offset those expectations.

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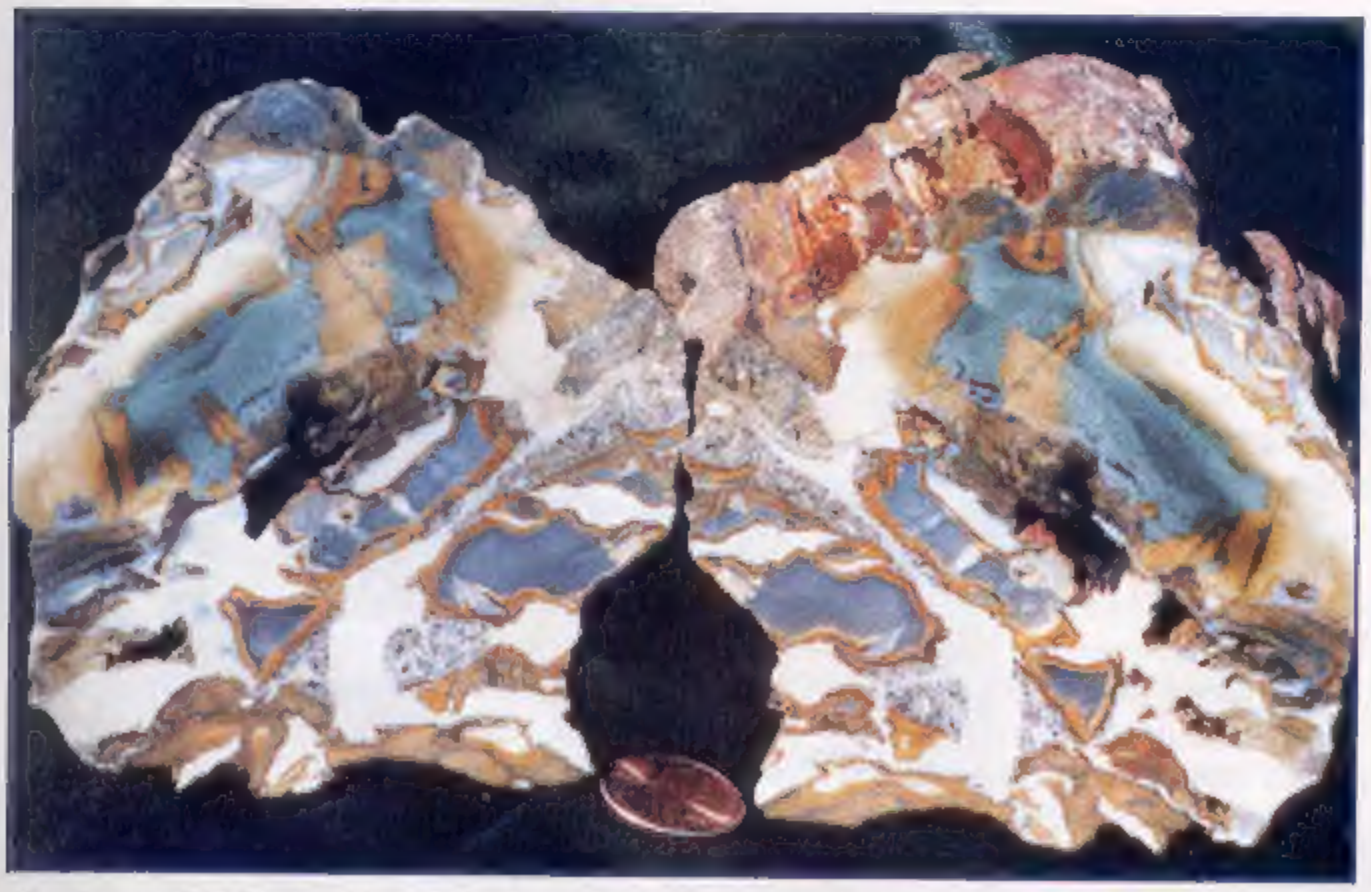


Someone went to the trouble of collecting this 5-pound piece of prized green Hampton Butte, Oregon, petrified wood, which I later bought.

Field Trips to Old Collections *from page 21*

There were slabs, too. The quantity was amazing! Not every one was gem-making material, but it was great fun searching through them for keepers. Quite a number of "sleepers" emerged after some clean-up; their potential had been hidden by years' worth of dust and dirt. Everyone was able to choose what satisfied them, and there was plenty leftover. I donated some of my slabs to our local club for the silent auction we hold during our annual (September) shows. After we selected what rock was of interest to us, the remainder was purchased by another club. So an old collection was shared and is now being enjoyed by many.

We also purchased a nice 18-inch slab saw from the lady, which we re-sold. While looking at other equipment, we found *more* slabs of some really nice old dendritic Robinson's agate from Eastern Oregon, which is no longer available. One of the best finds was several boxes (25 pounds) of the old pink and orange plumey Graveyard Point agate, a real treasure! In addition, a large number of individual slabs were laid out for display, priced at 25 cents to 50 cents apiece. A good many were of excellent ancestry and quality. It pays to be on the lookout for old rock. All of us have enjoyed our share of this find. I know I've had a great time discovering excellent and exciting "new" material as unidentified rock slabs from the past emerge from the saw.

Not long ago, a fellow rockhound who is always on the lookout for old collections called me about a recent trip he made to a garage sale. "They had some large thunder eggs," said Vern, "and some other rock for sale. We bought the eggs, but I didn't bother to look through the other stuff. Thought you might like to," he added. So, out I went to take a look. The house was only a few miles away.

"Down there by the driveway, you'll find some rock," said the lady when I asked. There were a few buckets and pans of miscellaneous rock stacked by a bank. One 5-gallon bucket was about half full of tumble-polished Oregon beach agates. They were coated with dust and dirt, but on closer inspection, I saw they were well polished.

"These look pretty good," I said. "Do you have any slabs around?" After thinking for a moment she replied, "Try looking under that blue box."

Under said box was a dishpan full of about 60 or so slabs. And many of them were hand-sized pieces of very plumey Graveyard agate from the Oregon/Idaho border. The lady and I visited for a while, then settled up for the beach agates, slabs, and a few other miscellaneous pieces (tiger's-eye, aventurine, leopard jasper, etc.). She thanked me for the $20 and I thanked her for the rock.

Back home, I called Vern. "You missed out on some good stuff," I chided.

"Figures," he said. "Like what?" And so went the conversation.

"But," I said, "as a finder's fee, I saved some Graveyard plume for you."

Equipment, too, can be found with old collections. My 18-inch hydraulic saw came to me this way, along with 400 or 500 pounds of nice rock. Several follow-up phone calls resulted in another trip to this source. Along with some nice Cow Creek "jade" (idacrase/serpentine) and other agates and wood came a 10-inch Highland Park trim/slab saw, another 6-inch trim saw, an 8-inch Highland Park arbor with leather polishing wheel(s), and a "bowl" grinder. The 10-inch saw was $20 and the other equipment another $20. Those were the asking prices, and we all went away happy. It was a lucky find, I must admit, but it makes up for some of those not-so-great deals!

You never know what treasures—and bargains—you might find when someone offers an old rock collection for sale.

My 16-inch slab saw had served me well for several years, but in view of my ever-growing pile of rock, I began to search for a bigger saw with which to cut bigger rocks. Responding to an ad, I discovered the previously mentioned vintage (mid-1960s) 18-inch Rogue hydraulic saw. I made a trip to check it out. Repairs were needed, but the price was right. We took it home wondering where to get parts. After some research, I found the saw was manufactured by a defunct rock shop in Medford, Oregon. Further digging turned up a pleasant surprise: The design rights had been purchased by a Jerry Porter of Salem, Oregon. My source, a fellow rockhound, said the saw was still being manufactured. I called Jerry, who said, "Yes, I still make the Rogue hydraulic saw, and yes, I can repair yours."

So, I made a trip to Salem with the saw. "Looks pretty good," was Jerry's verdict. "Doesn't look like it needs too much." He said he would call me when the saw was ready. A few weeks later, I received the call. I arrived at his home the next day, and we clamped a rock in the saw to try it out. The saw worked great! I allowed as how, now that the saw was fixed, I'd need some new rock to cut.

"I saw you looking at my pile of rock over there," replied Jerry. "How about some agate from Whitcomb Creek?" He generously fished six or eight nodules from a gunny sack. "These should make a nice addition to your collection," he said, and went on to say that they were no longer being found at the dig site.

These were the first rocks I cut with the newly repaired saw. I've enjoyed the saw and the rock ever since; the nodules turned out to be beauties. The Rogue saw, named for the famous Southern Oregon river, has been a joy. It cuts quickly, smoothly and cleanly. I much prefer it to my old screw-feed model; a hydraulic cylinder with a push rod feeds the vise into the saw blade, automatically maintaining a steady pressure, and it works its way rapidly through the hardest and softest parts of the rock. My slabbing time has been cut *way* down!

If you are in the market for a new or used saw, Jerry would be happy to provide information. He can be reached at (503) 371-7752 in Salem. You will also find him at the Pow Wow held every July 4th weekend at the fairgrounds in Madras, Oregon. He usually has a good supply of used lapidary equipment on display.

Jerry manufactures the Rogue saw in several sizes. He has shipped them all over the country and to China. Every collection of cutting rock deserves a good slab saw. I've enjoyed many happy hours in my shop with the saw humming along, producing many wonderful slabs. Digging and collecting rock is only part of the fun. Cutting allows you to create all manner of beautiful items from those stacks of slabs and specimens. I've since purchased several pieces of equipment from Jerry. He even makes a nifty "nub" holder for rock slabs and pieces. It also works great on thunder eggs.

continued on page 24

Field Trips to Old Collections *from page 22*

Old collections can be large or small. I remember a smaller one that came to my attention through a newspaper ad. It was here in the Roseburg area. I called and received directions and information. The collection was not a large one, but it contained some very good rock. There were excellent, large thunder eggs, along with moss agate, picture jasper, and some nice, large pieces of petrified wood. There was also a very nice 4-pound piece of bright green Australian chrysoprase. A general garage sale was underway, so along with the rock, I purchased a wheelbarrow ($10) and used it to haul my heavy rock buckets to the pickup. I picked up about 250 pounds, as I recall. I made the chrysoprase into some special little green turtles.

I'm still cutting and using some Brazilian agate nodules from another small pile of old rock. It came my way through visiting with a lady who often walked her dog near my workplace. She used to rockhound and offered to sell me her collection when I showed an interest. Another notable gain from this purchase was 3 pounds of tin oxide polish. I needed it!

And then came a *big* collection: many tons of famous Oregon petrified wood from the Sweet Home area in the Willamette Valley. Collected by Joe Kimble and his father over a period of many years, the pile had grown to quite an impressive size. This aged collection was not hard to track down, as Joe had let it be known that much of it had to be sold or moved. Selling seemed preferable. He was offering it by the ton, so again, several of us chipped in to make the purchase. Very large stumps and huge pieces were available, as well as gold sheen obsidian. Mixed in with the wood was an occasional chunk of "something." A pile of thunder eggs was spotted also.

Most fossil wood from the area surrounding Sweet Home is of excellent quality, and we were glad for the opportunity to get some of this "seasoned" old material. The beautiful ray-flecked sycamore wood from this area is especially coveted. We were able to find a good amount of it, as well as various other hardwoods and conifers. A good majority of Sweet Home wood is highly agatized, with very attractive and distinctive grain patterns, making it very popular. The colors are mostly earthy, but bright and sharp.

Then there was that large pile of assorted thunder eggs. "Joe, what about these," I asked, pointing to the pile in front of us. "Are they for sale, too?"

He answered, "Yes, same price." Soon several of us were filling buckets with eggs, some very large ones from the Black Rock Desert of Nevada. These turned out to be exceptional when cut in half. Many of the other thunder eggs could be identified as being from Succor Creek and the Richardson beds. Others were a bit of a mystery.

We spent the morning and afternoon sorting and filling our buckets from the mounded piles of wood. They were located in an open field with a view of the valley and hills surrounding the site. It was getting on to dusk by the time we had weighed and loaded up our buckets for the trip home. Spirits were high, and we thanked Joe for offering and sharing his cache.

I've since cut many pieces of all sizes and shapes, colors and patterns. The results have been very rewarding, producing special buckles, pendants and cabs and distinctive specimens and "stand-ups." Limb sections and rounds have also been cut and polished for display. Interestingly, nearly 100 species of trees (ancient and modern) have been identified from this prolific collecting area of Oregon. The area is also noted for its excellent dark red carnelian agate and the very famous Holley Blue agate, which has a unique lavender-blue color and takes a bright polish.

Opportunities abound in many communities to locate old-time collections of rock. Since not everyone can go afield to dig and collect, field trips to previously collected rock offers a good alternative for acquiring some quality cutting material or specimens. If you are not a rock club member, joining one can give you an inside track to seeking out items to add to your collection or to start one. Being an active member is beneficial to our hobby. Expansion touches more people, giving them an opportunity to enjoy the fun, excitement and benefits of rockhounding. Collecting rock is but one facet to enjoy. Collecting, be it in the field or at existing stockpiles, seems to be one of the main vehicles that drives most of the other rockhounding activities. Without that collected rock, where would we be?

I'm thankful for those vintage old collections. They are a wonderful resource for rockhounds, old and new.

ARKANSAS TURQUOISE

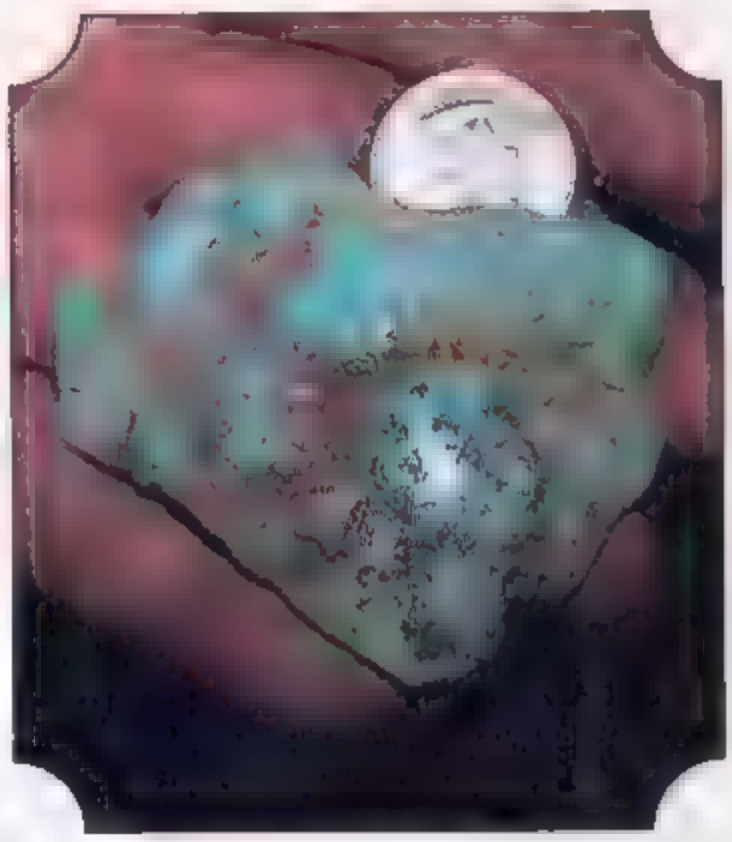
How I Became a Gem Miner

Story and Photos by Jack Wigley

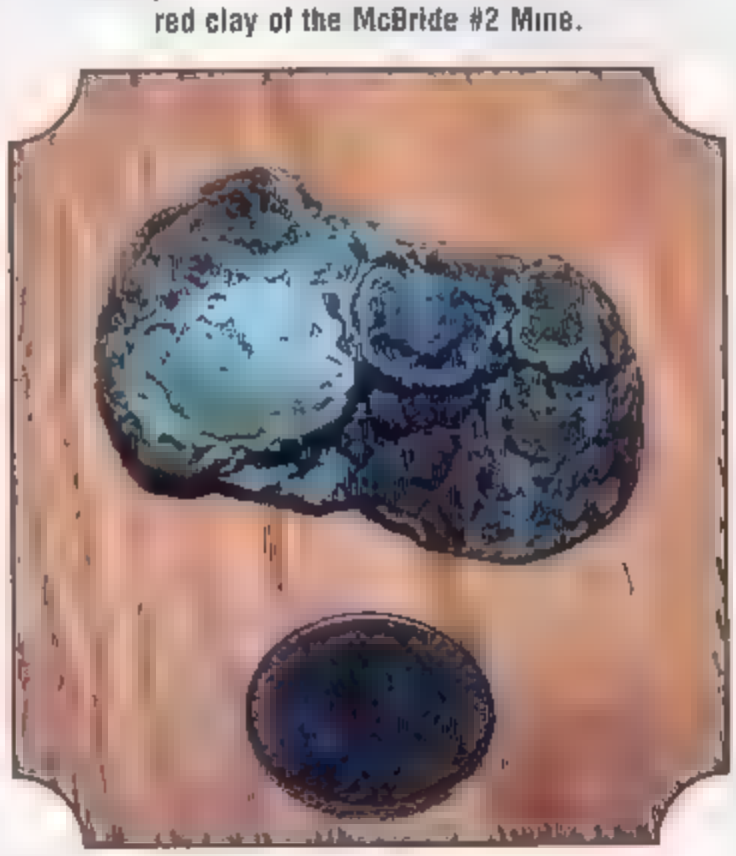
I lived in Dallas, Texas, for 35 years, from the time I was 21 years old. I have been involved in construction, in some form or another, most of my life. I eventually became self-employed and had a large lathing and plastering contracting business in Dallas. As my business continued to expand, I found myself with an office in Tucson, Arizona, around 1965. I saw signs everywhere for the rock and gem show in Tucson, and I made plans to attend. It was very large, and it blew my mind and my eyes. From that day forward, I was hooked on rocks and gemstones. Later on, I took three different lapidary classes for cabochons. I cut opal, jade and turquoise. I visited all the rock and gem shows I could and studied lapidary and rock and gem magazines as much as I could and still run my construction business.

In the early 1970s, I leased a mine in Tucson. This was my very first mining adventure. It was the mine where Earl Francis blew himself up with dynamite when the authorities were about to remove him by force. I hired workers and did a lot of drilling and digging, but had no luck and covered the mine back up. It was expensive, but as I learned, it was a fairly typical first-time mining adventure.

I ventured off into many other fields, inventing a process to recover silver from X-ray film, among other things. By now it was around 1980, and I was growing very tired of running my construction business. I became more and more interested in rocks and gems and in my new silver recovery system.



This specimen of turquoise was dug from the red clay of the McBride #2 Mine.



A cabochoned piece of turquoise from the McBride #2 Mine shows an intricate pattern.

Around this time, I was approached by a man from Mena, Arkansas.

He had asked my banker about someone who might be interested in turquoise and/or gold and silver mining at Mena. The banker told him I might be, as I was a very versatile person. I was interested – very interested!

I traveled to Mena, a place I had never been, right in the heart of the Ouachita Mountains. It was absolutely beautiful! I liked the idea of mining the turquoise, but at that time I was not interested in investing in the gold and silver mining. I immediately leased the turquoise mine and went to work on it.

According to the geology I studied, Ouachita Mountain is a part of the Appalachian chain, which is completely different from the Rocky Mountains. They are much older, which means more precipitation and more pressure, which changes minerals, like from coal to diamonds.

The turquoise mine is not far from the famous diamond mine at Murfreesboro and the large crystal mines at Mount Ida. The mine was discovered by Jack McBride in 1974. He built a small cabin out of small, native pine trees. It had a bed and chair, built out of the same pine, with a few other furnishing. (It was still there when I went to the mine.) He had mined about 600 pounds of turquoise out of a small shaft he dug. He sold at least 10 pounds to a couple of guys from Colorado, but I never knew what he got for it. He went back to his home state and died not long after. Another fellow named it the Mona Lisa Mine, but we prefer to call it the McBride Mine.

The mine is located southeast of Mena, at least 30 miles by road, on Little Porter Mountain, only a half mile or so from the Cossatot River. The road that goes up to the mine is very steep and rough and must be traveled in a 4-wheel-drive vehicle. I hired three men to work the mine, purchased some jackhammers and compressors, and went to work. (I didn't do any of the actual mining, I was still operating my construction business in Dallas.) I had the men work from the top of the ground, they never did go underground. They would work the cut, following the vein, and take out the turquoise. They used the jackhammers to widen the cut, then used a chisel and hammer so as not to damage the turquoise. We used a backhoe, but very little, and did some blasting where absolutely necessary, but we mostly worked it with small equipment because the kaolin clay was very soft and were able to take several tons of turquoise.

The turquoise and clay filled the crevices of the rocks. The miners followed this one cut about 15 feet deep, 5 feet wide, and perhaps a little over 200 feet long. We took some of the most fantastic, beautiful colors of blue turquoise from this mine. It ranges from a very dark, hard blue, some like Persian turquoise, to a very light blue to a whitish blue. We found some of the sea foam turquoise in this cut, in a very unique form. A great deal of this turquoise is the soft blue and would have to be stabilized before cutting. All the turquoise from this cut was mined out of kaolin clay. We mined out one large nugget weighing 380 pounds, we broke it as we took it out or it would have weighed about 500 pounds. This nugget is of the softer species and would have to be stabilized in order to cut stones from it. Of course, we don't know what is inside the nugget. We took several tons of turquoise at this location. The turquoise was dumped into 30-gallon and 55-gallon barrels and hauled to a shop building in Terrell, Texas.

When I started mining the turquoise, I did not know anything about turquoise. We put all the material we took out into a concrete mixer to get rid of the soft material, everything but the hard material was dumped. I saw one of the workers stick a #2 round point shovel in a large, soft blue nugget and start shoveling it out. He pitched most of it in the dump, but I picked up two pieces of it about the size of a brick and took them to my office and let them dry out.

About that time I learned about stabilization. It made me sick to think of that concrete mixer and all the beautiful turquoise I wasted. Well, so much for ignorance.

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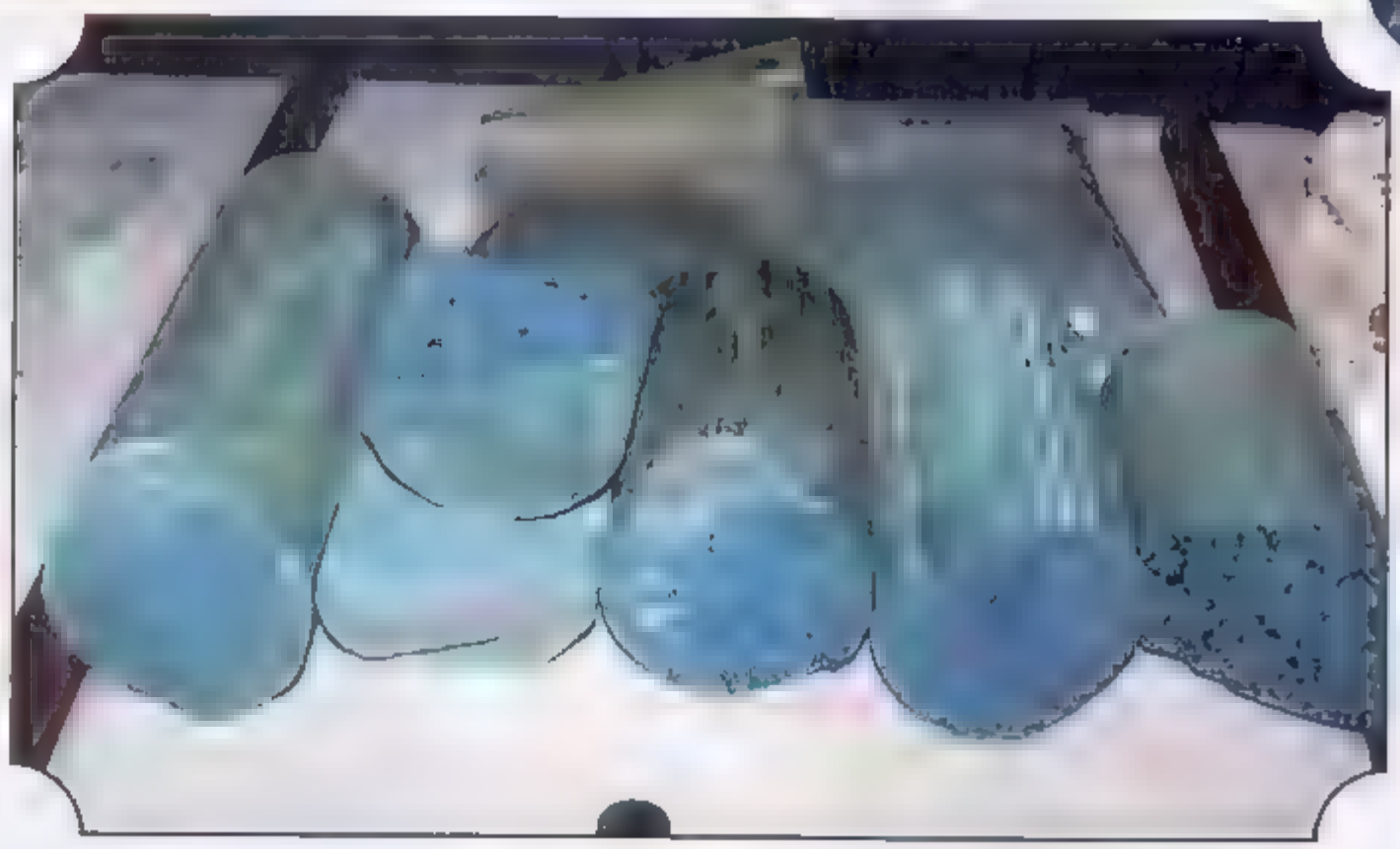
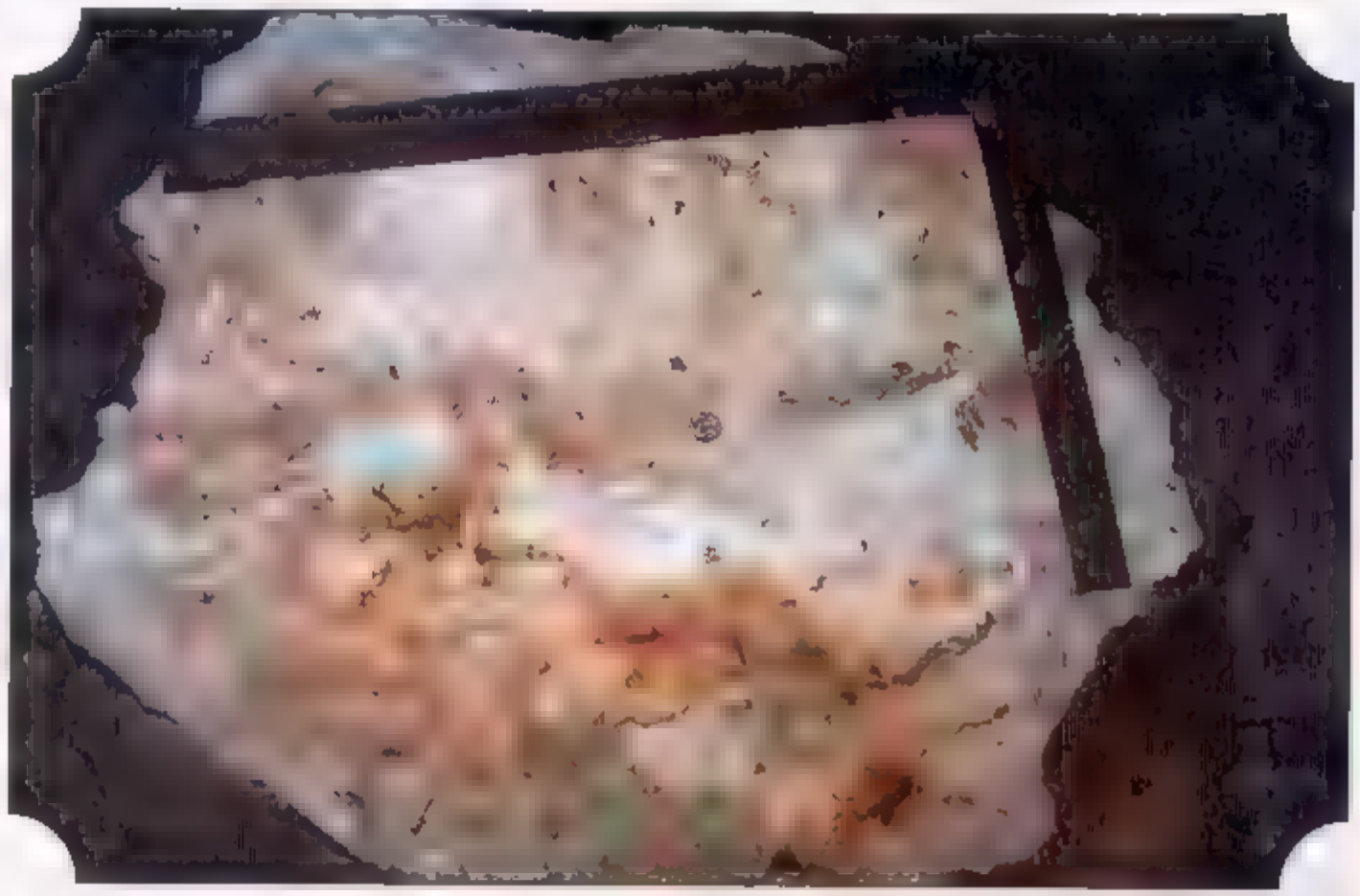
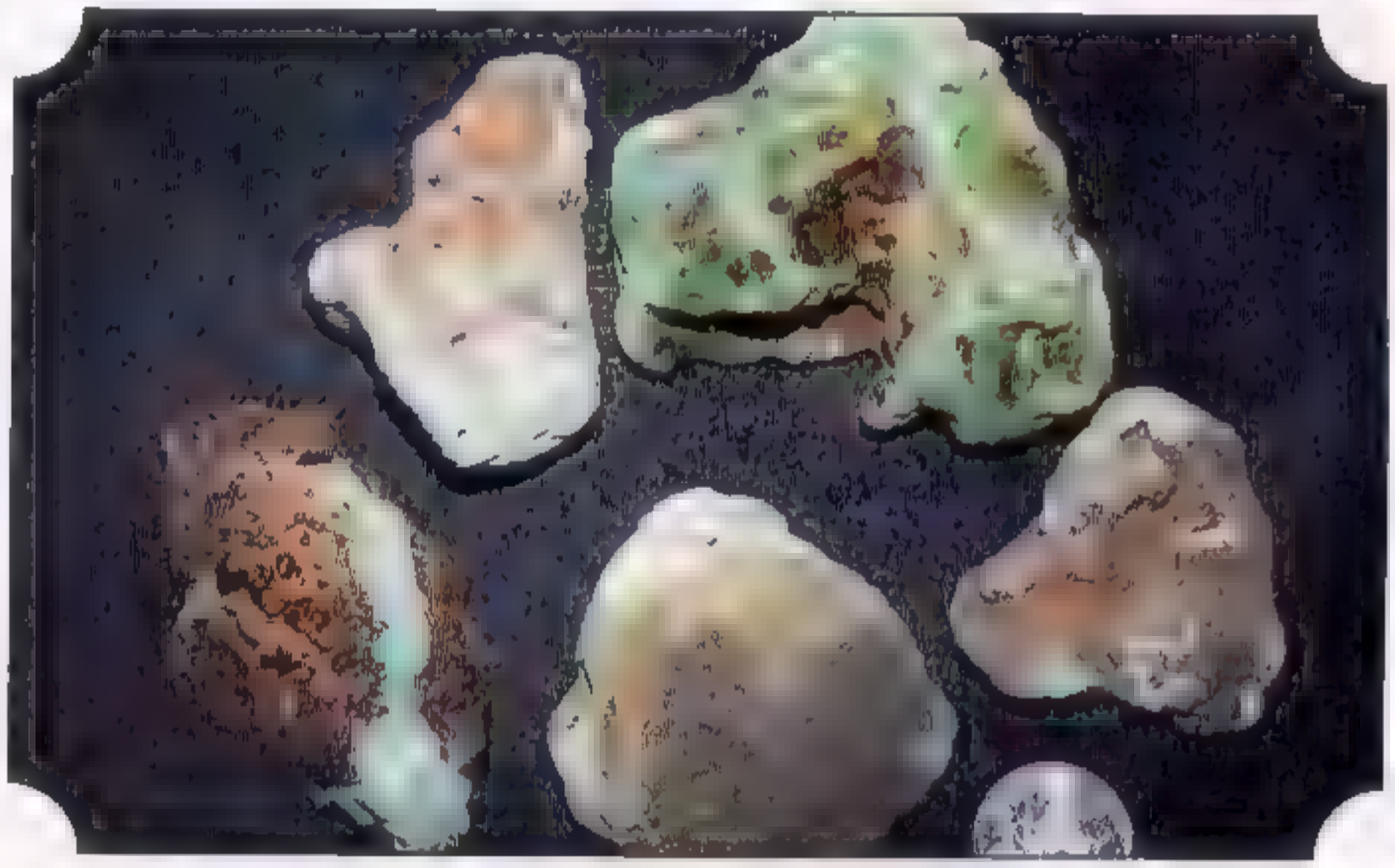


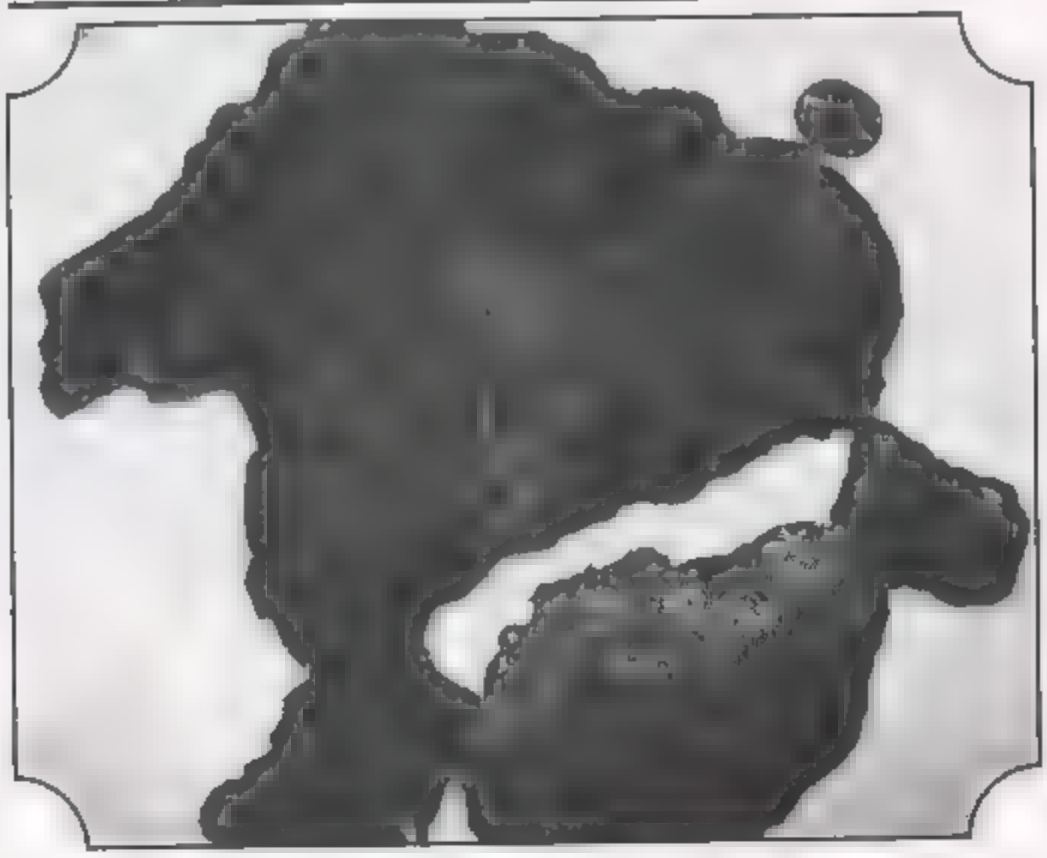
Reconstructed turquoise is made from small, soft pieces of turquoise crushed and compressed with resin.



When removing this 388-pound nugget from the McBride Mine, we broke a 100-pound chunk off it.



Large turquoise nuggets from the McBride #2 Mine will cut beautiful gemstones.



A rare high-grade manganese specimen from Polk County, Arkansas, runs to 65 percent pure

When I got all the turquoise with the kaolin matrix I wanted, we moved over about a quarter of a mile from the McBride Mine to another prospect. I had the men start a shaft where we had found some color, and sure enough, we found turquoise. We started taking hard green turquoise from the beginning. We followed this down about 15 to 16 feet, taking out turquoise all the way. It may go even deeper, but there was a nice vein widening out from the shaft, so we started drifting. We got about as much turquoise as we did waste. This mine was completely different, as the turquoise was in red clay instead of the kaolin and was full of nuggets, from fingertip size to two-fist chunks with all shades from white to green to almost black. It was all very hard. There was some turquoise in different shades of blue, and it was hard, also. Some of this turquoise can surprise you, because, as you cut and polish the green of it, it turns blue. I mined out several tons here, also. We dumped it into 30-gallon and 55-gallon barrels and hauled it to the shop. The biggest load I had at one time was approximately 5,000 pounds.

I gave up the lease for a few years, and some other people came and mined it for a period of time. They mined out several thousand pounds; probably altogether, we mined between 25,000 and 30,000 pounds, because I mined at least 12,000 pounds. I sold some, stabilized some, cut some stones myself, and stored the rest. An Indian silversmith from Tahlequah, Oklahoma made jewelry from some of the turquoise I had some of the stones set in gold, and they were beautiful. I think this turquoise is prettier in gold than in silver. Even though I still have my gem-cutting equipment, I have not fooled with it in several years. I have no cut stones anymore, as I ended up giving them to friends and family. Why? Because that is the kind of fellow I am!

I worked on the turquoise about two years or so and had a lot of turquoise on hand, so I closed the mine down with ideas of going back and opening it again. By this time, I had launched out into prospecting the Ouachita Mountains for gold and silver, and I am still involved in proving my findings. But that is a whole other story!

I am trying to completely retire and stop working, but I went out to the shop where my turquoise is stored and began looking at it. I ended up going through all of it, at first just a bucket or two, then a barrel or two, until I had separated all of it into different shades, kinds, hardnesses, etc. I had kind of forgotten what was there. We don't just have the small nuggets, we also have pieces that range from a half-pound to 20 pounds, of almost every shade and hardness. I am not a turquoise expert, but I believe we have some of the finest turquoise I have ever seen. You cannot find them any where else that I know of. Some of the turquoise has wavellite and other minerals on it.

I still have on hand several tons of turquoise in different grades, shades and hardnesses. Some needs reconstruction, some needs stabilizing, but a lot is just hard natural turquoise.

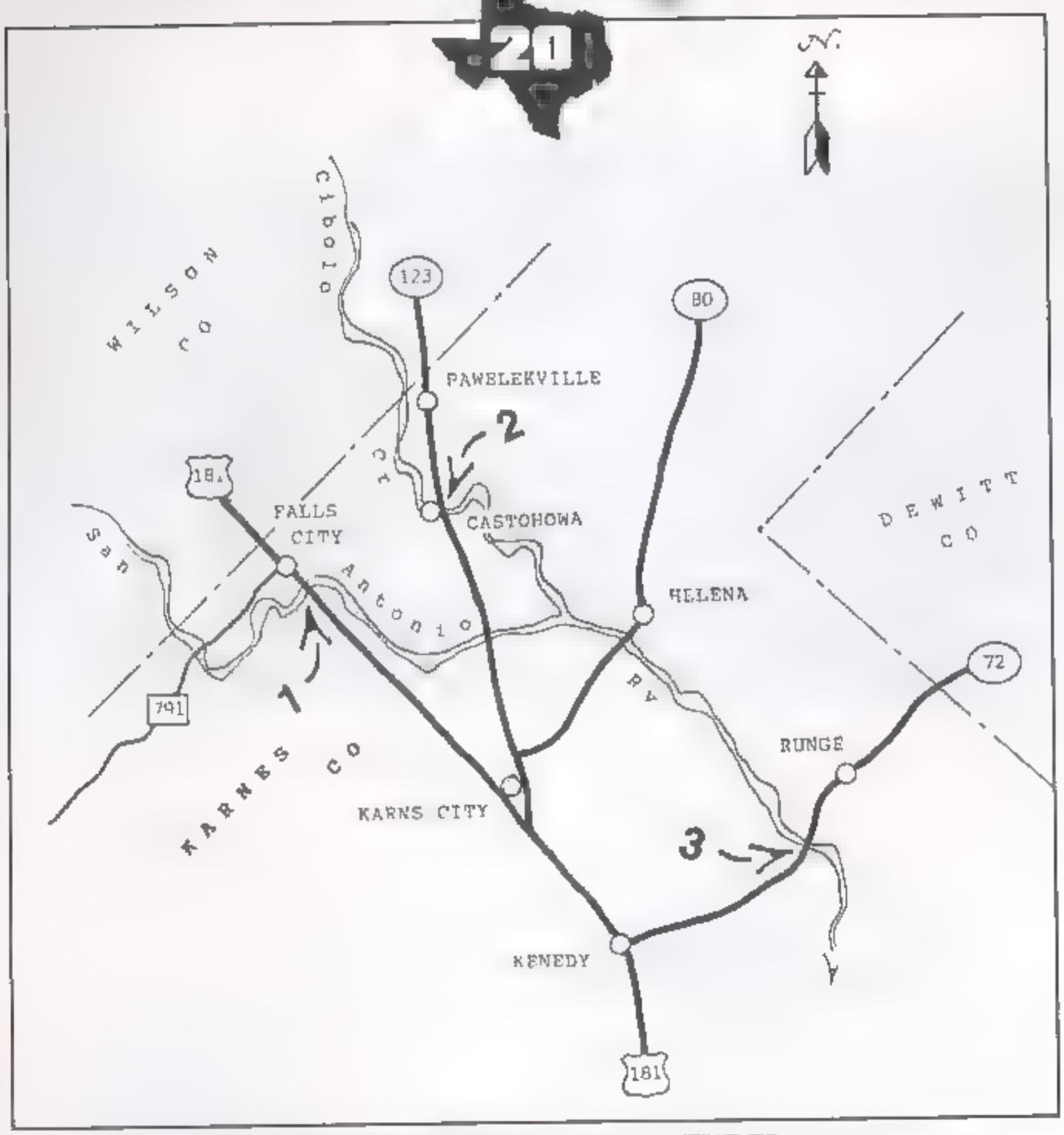
The Mona Lisa, or McBride, Mine is no longer open; we think it was mined out, but I am still in possession of Mine #2. If anyone is interested in the turquoise or information about the mines, you can write to Jack Wigley, 19604 Harvest Rd., Mena, AR 71953, call (479) 923-4541, or e-mail geraljack@yahoo.com. On your e-mail, please put "Turquoise" in your subject line.

GOLD AND GEM HIGHWAYS

ROADSIDE PANNING SITES IN TEXAS

Part III: Karnes, La Salle, Lavaca, Lee, Live Oak, and Llano Counties

Story and Maps
by David and Clois Walker



KARNES COUNTY (MAP TX20)

Site 1 **San Antonio River/U.S. Highway 181** crossing near **Falls City.** Vicinity finds include jasper, quartz, opalized wood, palm wood, and silicified wood

Site 2 **Cibolo Creek/state Route 123** crossing near **Castohowa.** Vicinity finds include opalized wood and silicified wood

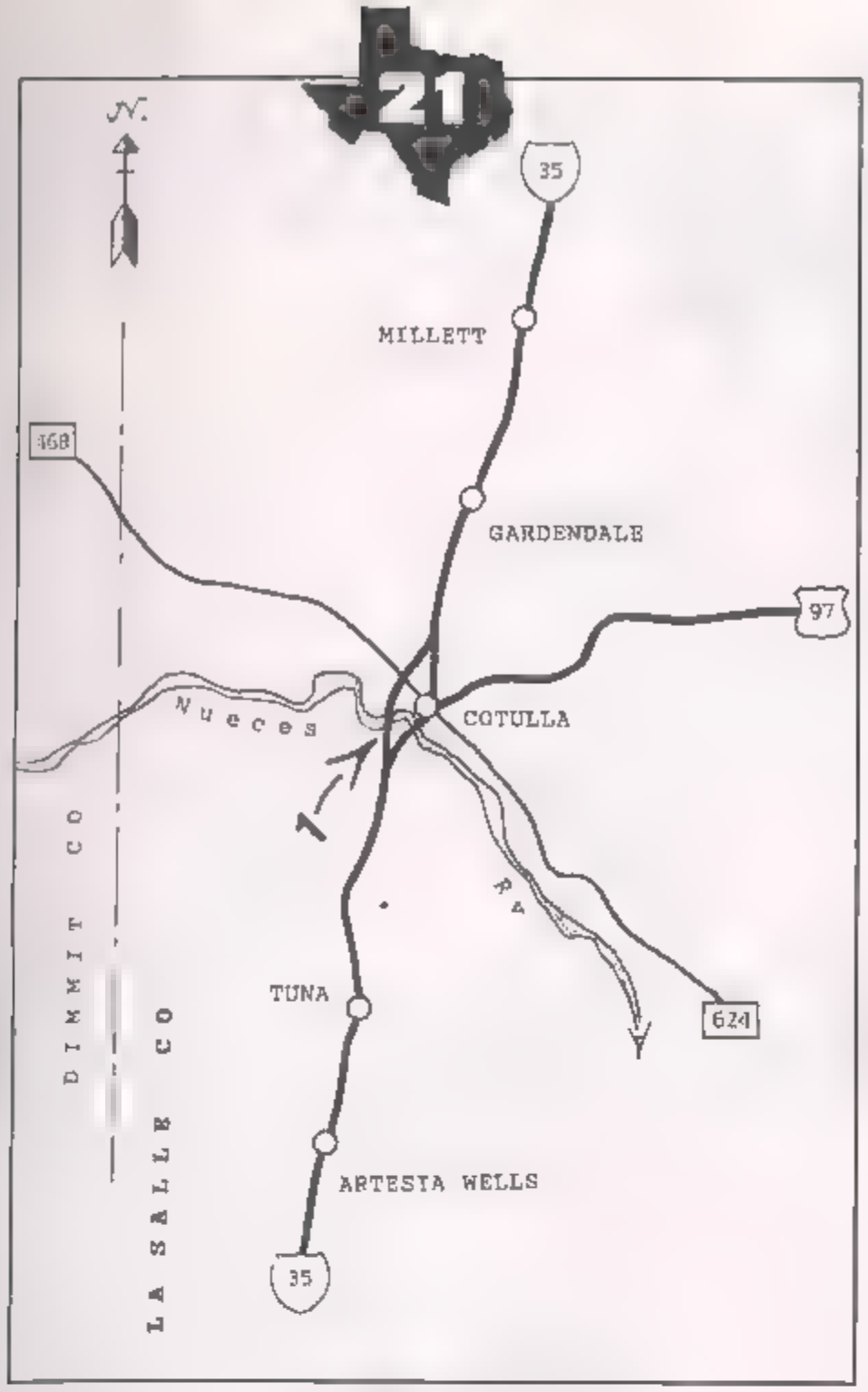
Site 3 **San Antonio River/state Route 72** crossing near **Kenedy.** Vicinity finds include agate, jasper, opalized wood and silicified wood

This is the third in a series of six articles containing county-by-county maps to suggested panning and screening sites at Texas highway stream crossings where appreciable finds have been previously reported in vicinity watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan.

By confining operations to within government-purchased highway rights of way, panners are spared the necessity of locating and obtaining permission from adjoining property owners, including state and national parks and Indian reservations. However, readers run the risk of prosecution if they cross onto private land, whether purposely or inadvertently. In instances where rights of way have merely been leased, other rules may apply. Visitors are urged to inform themselves of possible limitations by calling (512) 225-1462 *before* making a trip. The Texas Annual Vacation Guide, as a companionate source of information, is available by calling (800) 888-8839.

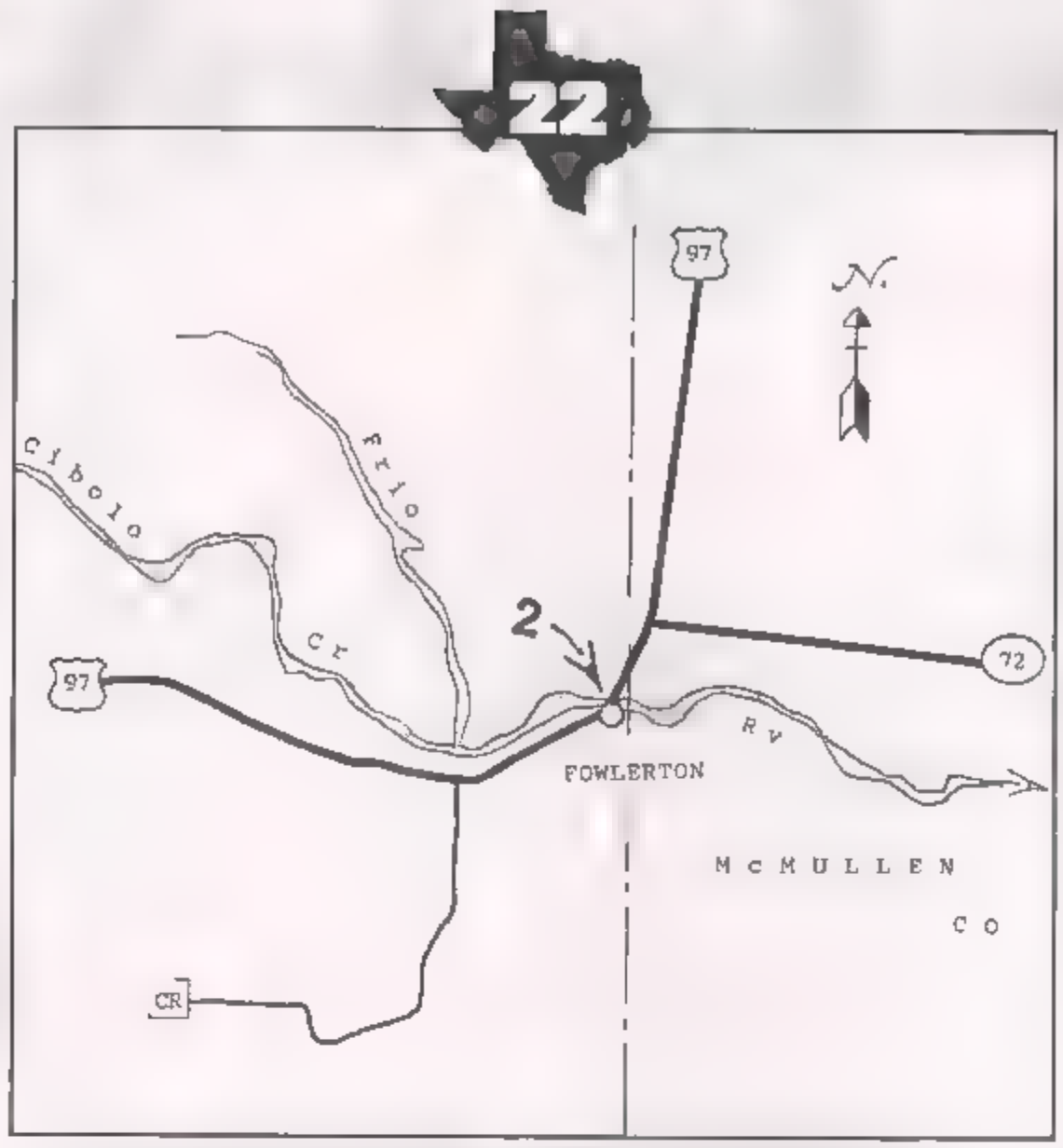
Remember that the government to which these rights of way belong has some regulations of its own. Observe highway safety and environmental standards, such as parking only where designated, and using only a pan and scoop.

The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway or county map when planning an outing, for overall orientation in the field and because highway designations have been known to change.

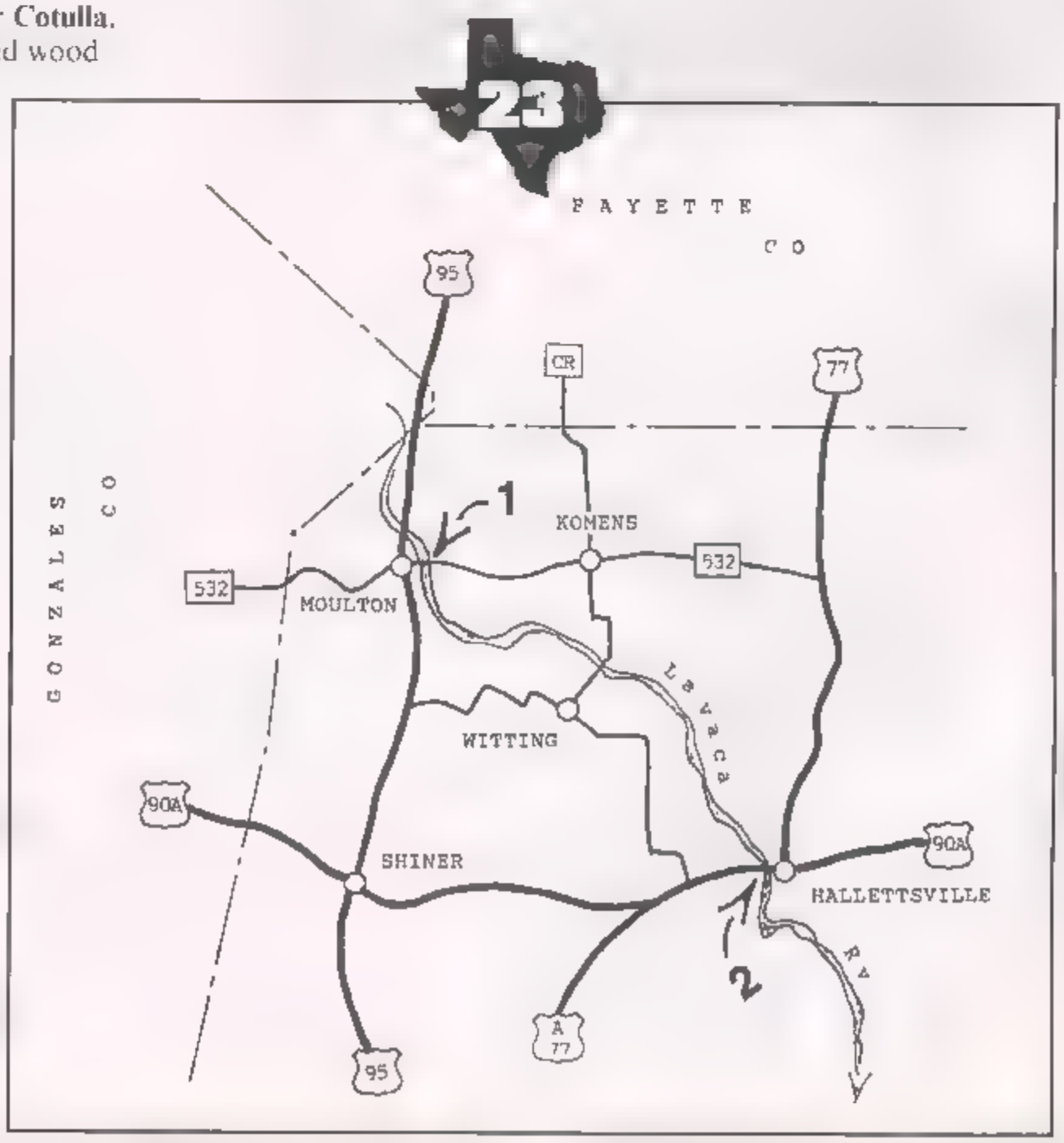


LA SALLE COUNTY
(MAPS TX21-22)

Site 1 **Nueces River/Interstate 35** crossing near **Cotulla.** Vicinity finds include palm wood, and silicified wood



Site 2 **Frio River/U.S. Highway 97** crossing near **Fowlerton.** Vicinity finds indicate silicified wood potential.



LAVACA COUNTY (MAP TX23)

Site 1 **Lavaca River/FMR 532** crossing near **Moulton.** Vicinity finds indicate silicified wood potential

Site 2. **Lavaca River/U.S. Highway 90A** crossing near **Hallettsville.** Vicinity finds include palm wood and silicified wood

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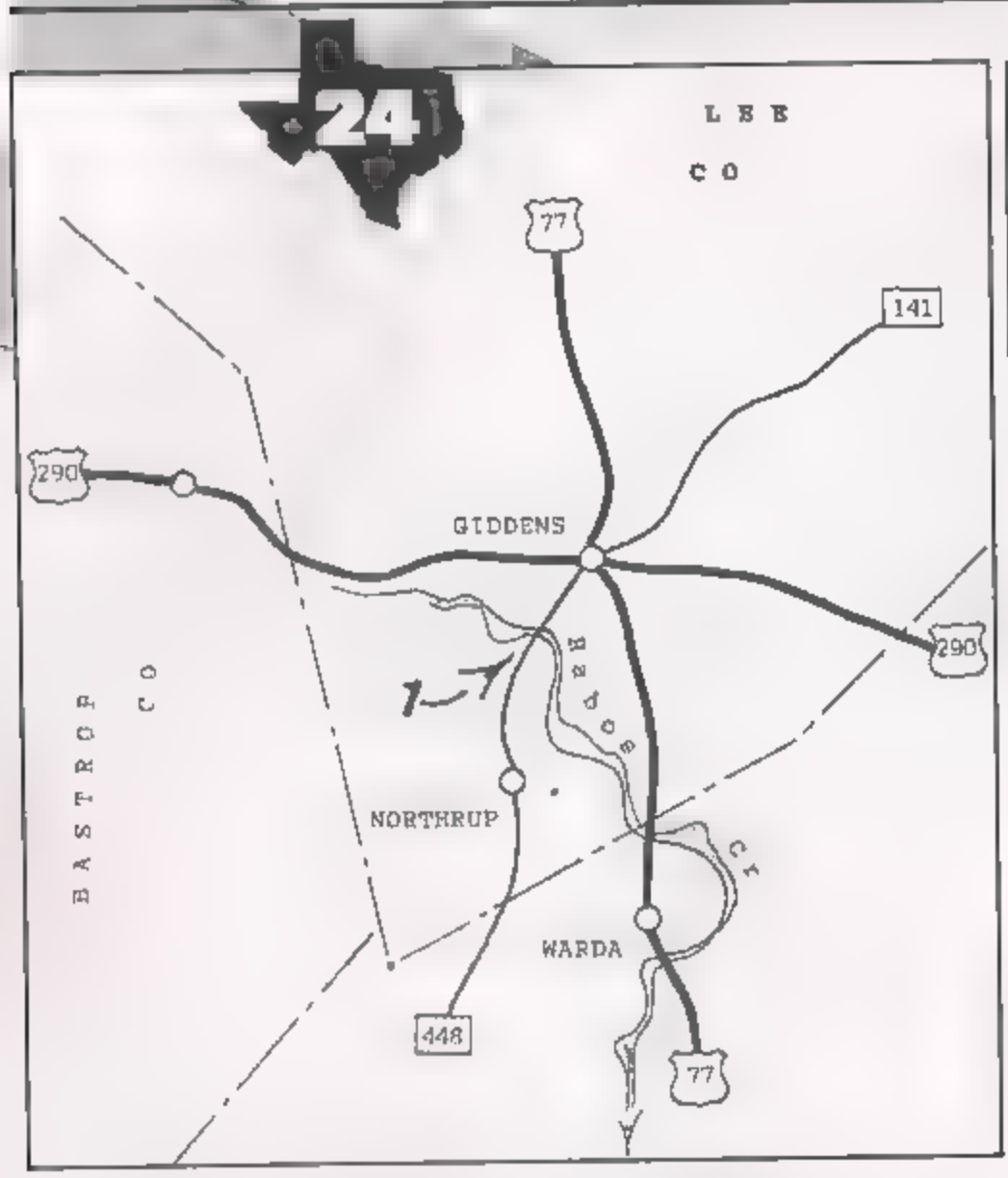
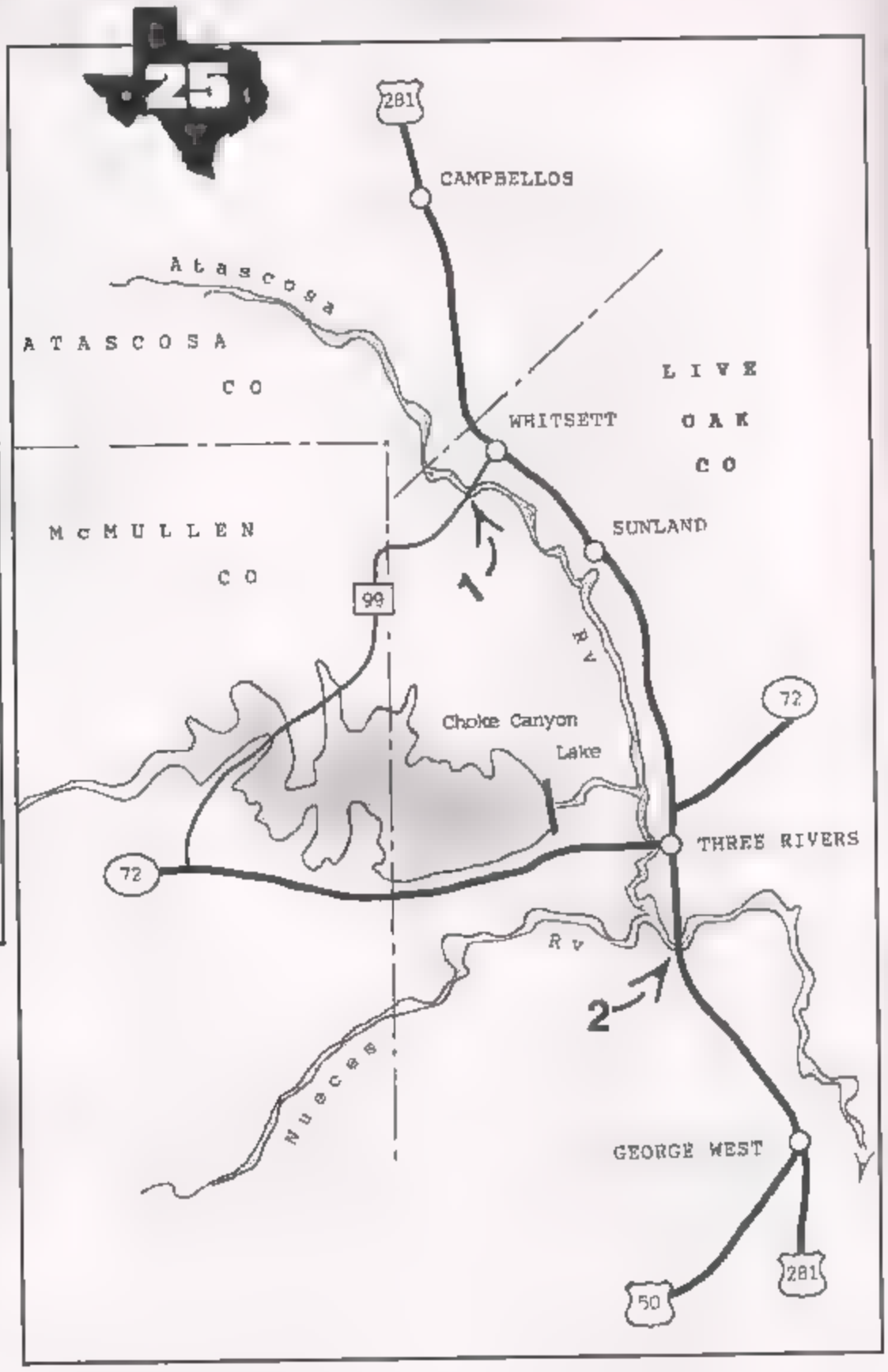


LEE COUNTY (MAP TX24)

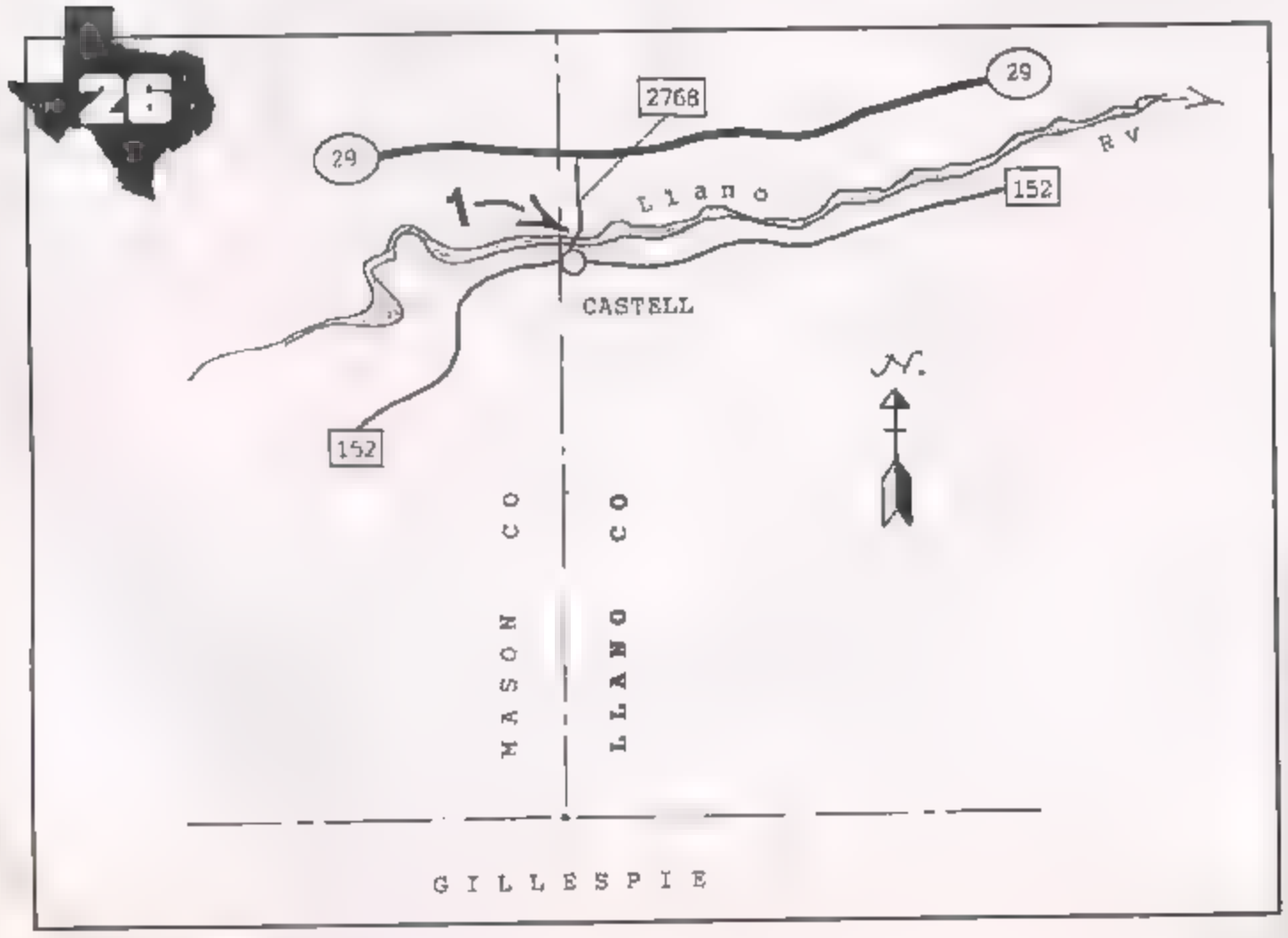
Site 1 **Rabos Creek/FMR 448** crossing near **Giddens.** Vicinity finds include palm wood and silicified wood



LIVE OAK COUNTY (MAP TX25)

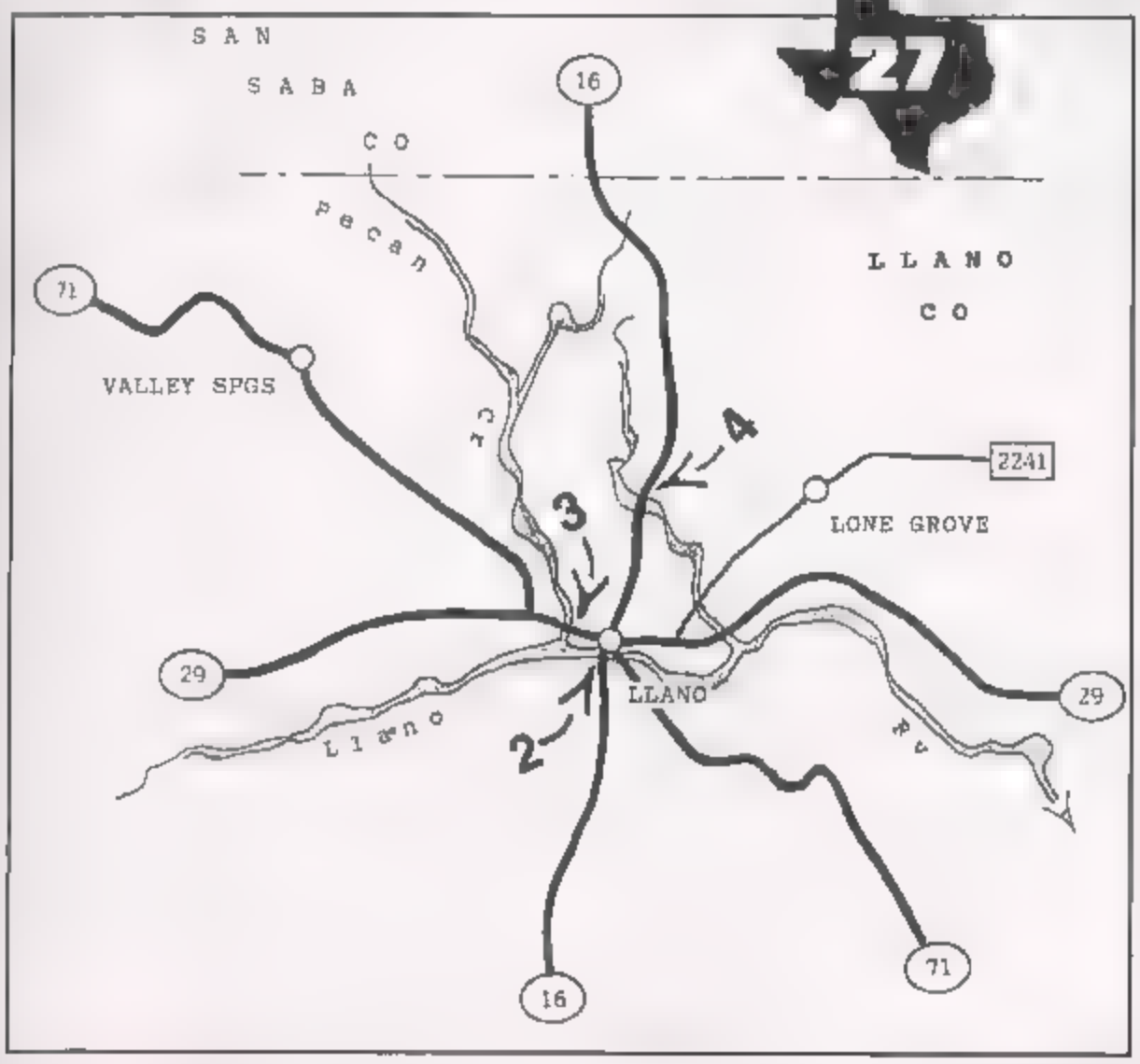
Site 1 **Atascosa River/FMR 99** crossing near **Whitsett.** Vicinity finds include palm wood and silicified wood

Site 2 **Nueces River/U.S. Highway 281** crossing near **Three Rivers.** Vicinity finds indicate silicified wood potential

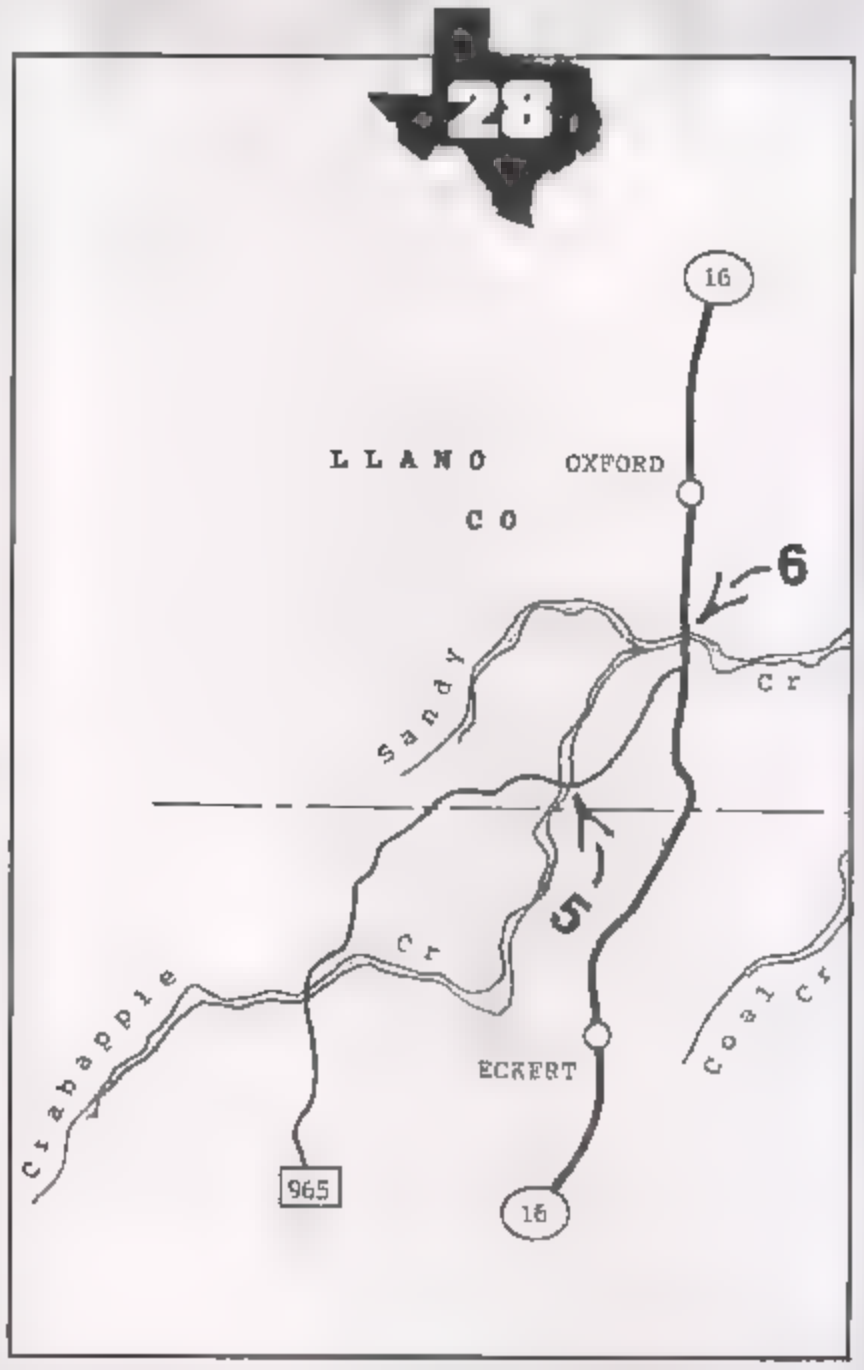


LLANO COUNTY (MAPS TX26-29)

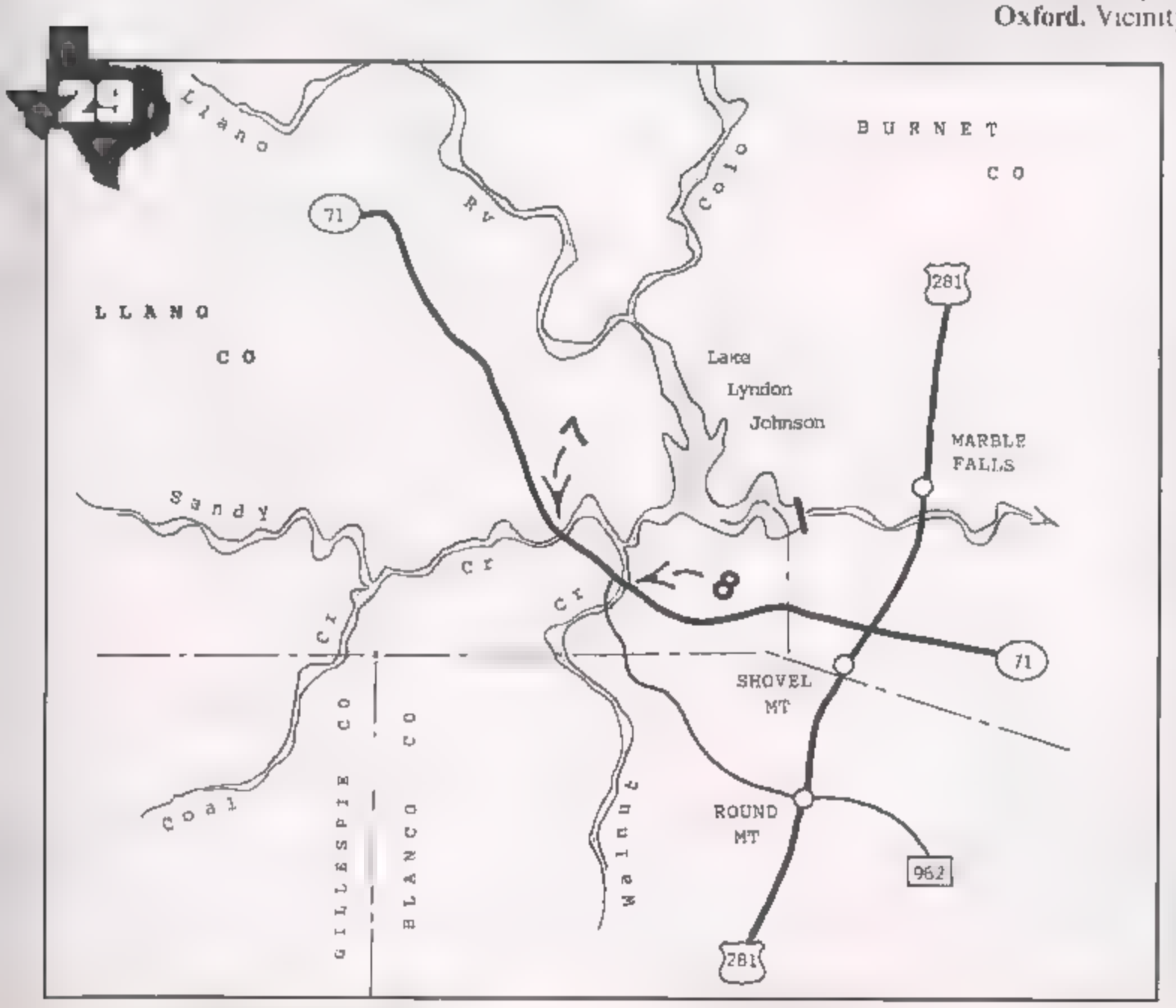
Site 1 **Llano River/FMR 152** crossing near **Castell.** Vicinity finds include tourmaline and zircon



Site 2 **Llano River/state Route 16** crossing near **Llano.** Vicinity finds include epidote, garnet, tourmaline, and zircon
Site 3 **Pecan Creek/state Route 29** crossing near **Llano.** Vicinity finds indicate llanite potential
Site 4 **Tributary Llano River/state Route 16** crossing near **Llano.** Vicinity finds indicate llanite potential



Site 5 **Crabapple Creek/FMR 965** crossing near **Oxford.** Vicinity finds indicate epidote potential
Site 6 **Sandy Creek/state Route 16** crossing near **Oxford.** Vicinity finds include garnet and quartz.



Site 7 **Coal Creek/state Route 71** crossing near **Shovel Mountian.** Vicinity finds include garnet and quartz.
Site 8. **Walnut Creek/state Route 71** crossing near **Shovel Mountain.** Vicinity finds indicate garnet potential.

ROCK & GEM

Make a Mineral Collecting Bag

WHAT YOU'LL NEED:
- An old pair of jeans
- Scissors for cutting cloth
- Sewing machine or needle and thread

KIDS

by Steve Bracker

Magnetite

Magnetite ($Fe^{2+}(Fe^{3+})_2O_4$) is found in igneous, metamorphic and sedimentary rocks, usually as small grains. In volcanic rocks, magnetite is found with pyroxene, olivine and apatite. In metamorphic rocks, magnetite may form with hematite and with iron hydroxides such as goethite. Often, the calcium iron silicate epidote can be found nearby. Magnetite can also form in hydrothermal environments.

Some studies suggest that fine-grained magnetite may form in soils with the help of magnetotopic bacteria. These microorganisms have been shown to produce a very distinctive type of magnetite when conditions are right. The bacteria forms a container around the magnetite to make it grow long and thin, then the bacteria can use the magnetite to orient themselves with the Earth's magnetic field. Some investigators have seen evidence of this type of magnetite in a meteorite thought to be from Mars, which suggests the possibility of extraterrestrial life.

Some magnetite is naturally magnetic and it will attract iron or other magnetite. This type of magnetite is called **lodestone**, and it was used as a navigational aid by ancient seafaring peoples. They would build a case around a piece of lodestone so that it could float in a bowl of water or be suspended by a string and allowed to orient itself with the Earth's magnetic lines of force, revealing the direction to the magnetic poles and acting as a compass.

There are a number of minerals that have iron in them. Since iron is attracted to a magnet, you might think that all the compounds formed from iron should be attracted as well. However, magnetite is the only common mineral that is strongly attracted to a magnet. Hematite, ankerite, siderite, goethite, and many other iron minerals have no magnetic properties. What makes magnetite different?

To begin to understand the difference, we will have to talk about a kind of chemical bond called the covalent bond. When elements are dissolved, they lose or gain electrons and become **ions** with a positive or negative charge. When ions have equal but opposite charges, they can combine to form chemical compounds. These opposite charges which hold the compound together, are called **covalent bonds**. The positive and negative charges of the ions have to be equal but opposite to form a stable compound.

Let's take a look at the chemical formula for hematite (Fe_2O_3). For this formula to balance, the two iron ions must be the kind that have a charge of +3, adding up to +6 because the three oxygen ions have a charge of -2 (-2 x 3 = -6). The charges, or **valences**, have to balance for a chemical compound to be stable. As you can see, the six positive charges of the (Fe^{3+}) ions are balanced by the six negative charges of the oxygen ions, making a stable molecule of hematite.

Next, let's look at the formula for magnetite ($Fe^{2+}(Fe^{3+})_2O_4$). The first iron ion in the compound has a charge of +2 and the second has a charge of +3. There are two of these +3 ions in the formula [$(Fe^{3+})_2$], therefore the positive charge adds up to +8. Oxygen ions have a charge of -2 and there are four of them in the formula, adding up to a charge of -8. These charges balance, and a stable molecule of magnetite can be formed.

The two different iron ions with two different charges are what make magnetite magnetic. The difference in charge creates a sort of electrical current, and from that current, a magnetic field is generated.

Magnetite forms opaque, black metallic crystals in the cubic system, usually octahedrons, though they rarely form cubes or rhombododecahedrons. It has a conchoidal fracture and is heavy, with a specific gravity of about 5.1 to

Rock & Gem Kids Quiz

The *Rock & Gem* Kids Quiz contest is open to U.S. residents age 18 and younger. All these questions can be answered by carefully reading this column. Write your answers neatly on a postcard or 4X6 card and mail to: Rock & Gem Kids Quiz, P.O. Box 6924, Ventura, CA 93006-9899. Valid entries received by Apr. 30, 2006 will be entered in a drawing from which five winners will be chosen. Valid entries must be the entrant's own work, must be postmarked on or before the deadline and address of the entrant's parent or guardian. Prizes are personal, provided by the Arizona Mineral and Mining Museum Foundation.

Magnetite is an [illegible] and [illegible] rocks.

Magnetotopic [illegible] to orient themselves to the Earth's [illegible].

Natural [illegible] is called [illegible].

The equal but opposite [illegible] is called [illegible].

The [illegible] different [illegible] with two different [illegible] make [illegible] magnetite.

FIELD TRIP

Alton, Illinois, Travertine

The travertine forms on the limestone, and breaking pieces shows how the layers have formed

The waterfalls and the travertine deposits are at the end of a short trail and are an easy walk from the parking lot.

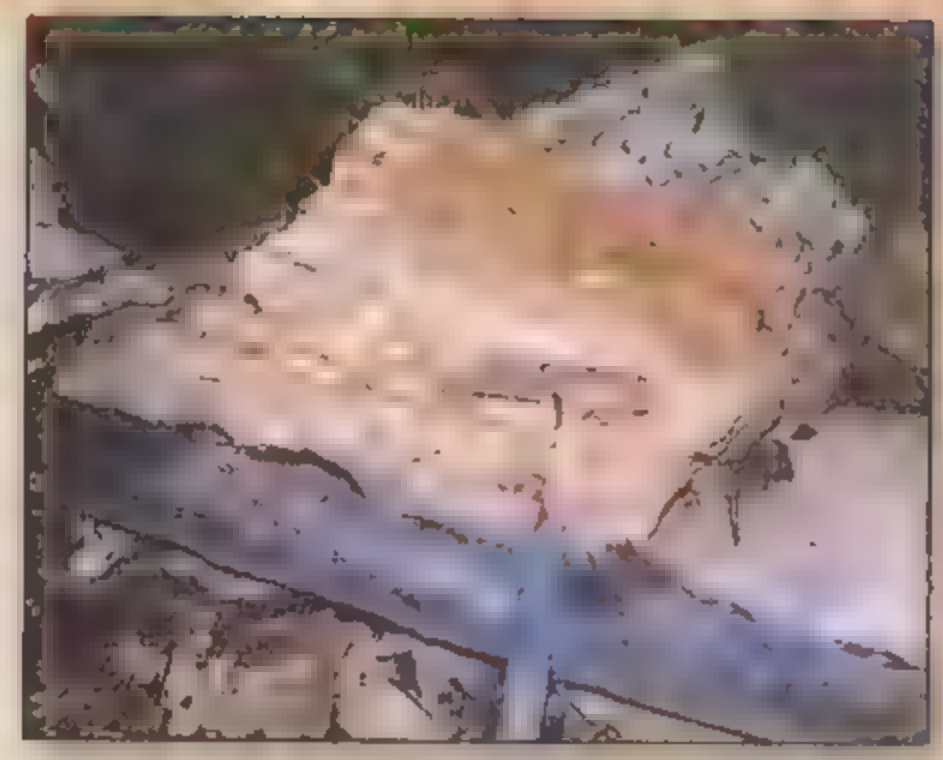
The flowstone and travertine often form on pieces of limestone as small, rounded aggregates.

An Easy-Access Dripstone Collecting Site

Story and Photos by Robert Beard

Some of the most unique collecting sites can be found with just an awareness of your surroundings and the local geology. During a recent trip (August 2005) to the St. Louis, Missouri, area, my family went to the Raging Rivers water park in Grafton, Illinois. To get there, we had a fairly long drive through Madison and Jersey counties in Illinois. As I am always looking to combine family trips with rockhounding, I researched the geology of the area and consulted some of my local mineral guides for ideas prior to our trip. One of these references, *Earth Treasures, Vol. 1: Treasures of the Northeastern Quadrant*, by Allan W. Eckert (www.iUniverse.com, 2000), indicated that there would be trilobites in the limestone quarries along the Mississippi River near Grafton. Grafton is a very small town on the river, and the largest city we would pass through was Alton, Illinois.

The desposition of the small globular aggregates is so rapid that many are too fragile to collect.



Large pieces with excellent flow patterns are easily chiseled off the highwalls

Even if the rocks are loaded with fossils or minerals, you must find an accessible location for collecting. Many areas are private land, and public land such as parks, is sometimes off limits to collectors. Road cuts are often good collecting sites, but in many states it is against the law to collect at road cuts. I have seen many good road collecting sites marked off limits by either the highway department or the landowner.

On our way to the water park, just south of Alton, we saw a sign describing a strange thing known as the Piasa Bird. The Piasa Bird is an Alton area legend. In recording his 1673 journey down the Mississippi River with Louis Joliet, Fr. Jacques Marquette described a birdlike monster painted high on the bluffs along the Mississippi River near the present town of Alton. In the language of the Illini Indians, the bird was called the Piasa, a bird that devours men.

The Piasa Bird would certainly have been a useful landmark in those days, as the Mississippi was a tough river to explore. Unfortunately, all the research I have done on the Piasa Bird only gives details about the Indian legend, and not the exact location of the original painting. Apparently, the original Piasa Bird is long gone.

We did not drive through Alton, but past it on the main highway. I watched for any interesting outcrops where we could see some rocks, and we soon passed some large quarry highwalls. I then saw a turnoff for a small roadside park after a large storage area for truck trailers, and we pulled into it. I thought this looked like an ideal area to check for fossils or minerals in the rocks.

The edges of the park have huge limestone cliffs, and we saw a huge painting of the Piasa Bird emblazoned on the cliff facing the parking lot. It's one ugly bird and one of the stranger landmarks I have seen. It has teeth, antlers, scales for feathers, wings patterned like the American flag, and the face of a man. The painting was done in 1998 and is still in excellent condition. It is high enough on the cliff to keep it from being easily vandalized.

Small towns that have a local legend are usually good at making the most of it, and Alton is no exception. However, I am sure the park planners meant for people to come to see the Piasa Bird and not to collect rocks. Although I found the Piasa Bird intriguing, my main interest was in the rocks. I just wanted to make certain there were not any "No Trespassing" or "No Rock Collecting" signs. Fortunately, I did not see any signs indicating collecting was prohibited.

Huge underground workings had been carved out of the limestone, these were all fenced and inaccessible. At first, I thought we could find some fossils or calcite crystals in the limestone of the outcrops near the parking area that were not fenced. Unfortunately, I did not see any signs of any collectible fossils or minerals, and certainly not any of the geodes or nodules in the area. I was just about to walk back to the car when I heard a faint sound of running water. I thought it was worth checking out, if I could not find any fossils or minerals, perhaps we could see a good waterfall.

A trail leads from the parking lot to the cliffs, and it's a very short walk. The trail goes past the truck trailer storage area, which is fenced in and separated from the trail. Since this was August, the vegetative growth was heavy, but it was obvious that this trail got a lot of use. I soon saw the waterfall and went back to get my mother and the kids.

The waterfall was quite a sight. The water was pouring off the limestone cliffs, and it was very scenic. It's interesting what you can find by walking down the beaten path at a park instead of driving in directly at the edge of the cliffs. Because the kids snapped me to leave, and we all wanted to get to the water park. However, I collected some beautiful rock formations on the way out. Travertine exists in many of the limestone pieces, and there are pisolites or dripstones and small nodules or geodes. Of course, I was not in appropriate time to do much rock collecting trip. I would come back another day.

According to a map by the Illinois Geological Survey, the rock that forms the highwalls is a long cross section of the Ste. Genevieve Mississippian limestone. The limestone is covered by a thick cover of glacial debris from the Illinois episode of glaciation, which occurred about 300,000 to 130,000 years before the present. The glacial debris consists of scratched pebbles from Paleozoic shales and sandstones, with a large input from the local rocks. The cover generally ranges from 5 feet to 45 feet thick.

Nearly all of Illinois is covered to some degree with glacial deposits from the Pleistocene. The rocks will be exposed on or near to the northwestern and southern sections of the state and bedrock exposures along the Mississippi River. While this search may seem to eliminate many collecting possibilities, it actually helps by dramatically narrowing the locations for collecting. Your collecting will be strictly limited to bedrock exposures along the larger rivers and creeks or the rocks that are exposed by quarrying. At the Alton site near the Piasa Bird, exposures include the cliffs and the old natural workings that date back to the mining. Apparently, it was more economic to mine the rock underground than to strip off the thick overburden that covered the limestone.

continued on next page

Illinois Travertine *from page 53*

The town of Alton is five miles north of the junction of the Missouri River with the Mississippi River, and it is about 25 miles north of St. Louis. Many important events in American history occurred here. Abolitionist editor Elijah P. Lovejoy was slain here in 1837 by a pro-slavery mob, and the final of the seven Lincoln-Douglas debates was held in Alton in 1858. At the time, Illinois was a free state, while Missouri was a slave state. During the Civil War, Alton was the site of the Alton Federal Military Prison. Robert Wadlow, who still holds the *Guinness Book of World Records* title as the tallest human in history (8 feet, 11 inches!) was from Alton.

Given its location on the river and proximity to barge traffic and rail lines, Alton also developed a strong industrial base as river traffic boomed. As in many industrial cities of the Midwest, much of that base is now gone. In a sense, this is good for collecting at the cliffs near the park, as the quarry and underground mines have long been abandoned. While there is still some industry, Alton has redeveloped part of itself for tourism. Eagle watching is popular during the winter, as approximately 200 to 400 American bald eagles visit the area between Alton and Grafton between November and February. However, eagle watching does not generate a lot of revenue, so the town has developed a tried-and-true method of bringing in dollars: the Alton Belle Casino located on a permanently moored riverboat on the Mississippi River.

Although the summer of 2005 was dry for the St. Louis region, I managed to time my return visit during one of the only rainy days of the year, Aug. 18. Normally, I would not have gone in the rain, but we were to return to Pennsylvania the following day. I also thought that the rain might generate some additional waterfalls and tell me where the best travertine might be located. When I arrived in Alton, it was raining pretty hard, and so I made a detour to the Alton Belle Casino for a short time. Casinos are not the best places to kill time if you are on a limited budget, but I was able to stay out of trouble until the rain let up enough to go to the site.

The site is only a few minutes northwest of the casino. I parked my car in the Pizza Hut parking lot and hiked to the waterfall we had visited a few days before. On my GPS unit, the waterfall was at 38° 53.907 minutes N, 90° 11.785 minutes W. I also took a GPS reading of the parking area, but the parking area coordinates did not match up with later checking using a topographic map, while the waterfall

coordinates appeared to be correct. The rain had started again, and both rain and waterfalls were coming down pretty hard. I found some more nice pieces of travertine dripstone at this site, and then worked my way to the southeast, where I suspected there were additional underground workings.

The weather was terrible, and I could not keep anything dry, including my camera. At least, I thought, the weather would guarantee me solitude. Many of the underground workings were undoubtedly used by teenagers for partying and who knows what else, judging by the graffiti, beer cans, and broken bottles. This is not a good hangout when it is raining.

Fortunately, the highwalls were now full of waterfalls, and by following the water, it was easy to find the deposits of travertine and dripstone. The travertine is different than many of the deposits I have seen in the western United States, as the deposition is made by cool water, and no hot springs are present. The rainwater or shallow groundwater has leached what it can from the limestone, based on the temperature, pH, and other characteristics of the water. The cool temperature of the water is an important limiting factor and prevents the additional dissolution and deposition of the significant amounts of sulfur and other minerals that might be expected if this were a hot spring.

The deposition of the travertine and dripstone is extremely rapid. An abundant amount of organic material, such as algae, bacteria, and wood fragments get caught in the deposition. In some areas, this accounts for deposits on the highwalls that are dark red and green. Many sections are covered with thousands of small marble-size globules of travertine, but in many cases these are just being formed and are too soft to be broken off as specimens.

The larger waterfalls have some interesting pieces. One of the largest waterfalls is located at 38° 53.849 N, 90° 11.753 W, and has excellent sections of flowstone with stalactite and stalagmite structures. I was able to easily chisel off some nice pieces. Some of the larger pieces had encased large sticks, and the wood appeared to be relatively recent. Based on the flow rate and appearance of the wood, I suspected that many of the deposits were only a few years old. The deposition of travertine and dripstone along the highwalls is extremely quick, and new layers are forming constantly.

The best places for large pieces are at the bigger waterfalls, and you can chisel off pieces from the walls, or look for pieces that have fallen off the sides. A chisel and a good hammer are very useful tools at this site, and are far better than just a hammer. During my visit in August 2005, I found that the area was heavily overgrown with brush, and it was difficult to walk along the base of the highwalls without tripping on exposed roots and rocks. It was also pouring rain, to the point that it was almost difficult to see.

The Piasa Bird emblazoned on the cliff facing the parking lot is an excellent landmark for the site.

I soon picked out several pieces to take out. One of these was a large piece like a stalagmite that had a nice orange- and white pattern. I also picked several pieces with the aggregates of globules and pieces with terracelike flow patterns. I filled a large bucket and carried the biggest pieces I could down the trail to the parking lot.

I did not count on the scene at the parking lot. Instead of partying teenagers, a large contingent of senior citizens had converged on the parking area to see the Piasa Bird, despite the rain. I never like coming up to a large group of people when I am carrying out rocks, as I am always concerned someone will not like the fact that I am removing material, despite the lack of any posted restrictions. In this case, my stalagmite-like booty probably made me look like a cave robber.

To make matters worse, a police car was also driving around the parking lot. You definitely do not want to run into the local police if you are carrying out a bunch of rocks, even if there are no signs against collecting. The police would have not been impressed with my looks either, as I was muddy, soaking wet, unshaven, and had the general appearance of a bum. In other words, I looked exactly like a field geologist.

The police car was apparently just making its standard drive through the parking lot. It circled once and left. I was able to go to my car and load the rocks without incident. In all likelihood, no one cared a whit that I was collecting rocks from the old quarry, but it is always best to keep a low profile just the same.

I later had the chance to look at the travertine in greater detail. Since the deposition was so rapid, much of the organic material in the deposits soon began to decompose and give the rocks a bad odor. I found this was easy to fix by soaking them in a strong solution of sodium hypochlorite (bleach), which I purchase at any local home improvement store. This killed the bacteria and helped to clean some of the algae and dirt off the pieces, and many of them became an attractive white. The bleach can take care of the organic material and discolored areas while not dissolving the travertine. Some of the flatter pieces made excellent stepping stones for our garden, and the terraced sections made nice sloping edges.

I also found that much of the travertine had formed as surface material on pieces of limestone. If hit with a hammer, the travertine shell would often break off. For this reason, it is best to not try to do excessive trimming with your hammer.

To get to the site from St. Louis, take U.S. Highway 67 north to where it crosses the Mississippi River at Alton, and turn northwest on state Route 100 along the river. From the eastern side of the river, take state Route 143 to Alton, and get on state Route 100 heading northwest along the river. The parking area, which is well marked by the Piasa Bird, is only about one mile northwest of Alton and is just past a large, fenced truck trailer storage area. The trail is found on the northeast corner of the parking lot, and it heads east toward the highwalls. The collecting areas beneath the waterfalls are best, but good specimens can be found throughout the base of the highwall.

This site makes a very easy and convenient stop if you are in the St. Louis region, and can easily be combined with some of the other tourist activities in the area. The Piasa Bird painting on the cliffs makes the spot almost impossible to miss, and parking is abundant. Visiting the area on a dry day, especially in the fall or early spring before the thick undergrowth takes over, will likely pay off in some very interesting pieces of travertine.

Montana Gold Panning

Try Your Luck at This Recreational Site

Story and Photos by Kenneth H. Rohm

Northwest Montana Gold Prospectors Club member Harry Pitman shows off his collection of gold nuggets

Some time ago, I stumbled upon some information on a place in northwestern Montana where the public is allowed to actually pan for gold. What a wonderful way to spend time: fresh mountain air, invigorating exercise, and the prospect of actually recovering gold. I could visualize myself working the stream just like those sourdough prospectors did 150 years ago. It didn't take long for me to decide that I'd have to visit this area and try my hand at it.

Time passed, and although I continued to think about going there, something always came up to interfere with making any plans. But recently, I finally managed to find time to make the trip that I'd been looking forward to for so long.

I was in Montana and had one free week on my hands before I had to return home. What better way to spend it than panning for that precious metal? So upon finishing my business, I headed northwest to Libby Creek, south of the city by the same name. I was not disappointed.

Gold! The very word conjures up visions of glittering wealth. History is full of stories attributed to this precious metal. Wars have been fought over it. Whole nations have become enslaved because of it. People have exerted almost super-human energy in their efforts to recover it from its hiding places in the earth and from one another.

Throughout history, human beings from all walks of life have worshipped gold. Yet, this honey colored metallic element is so ridiculously soft it has very little intrinsic value as a tool of any sort.

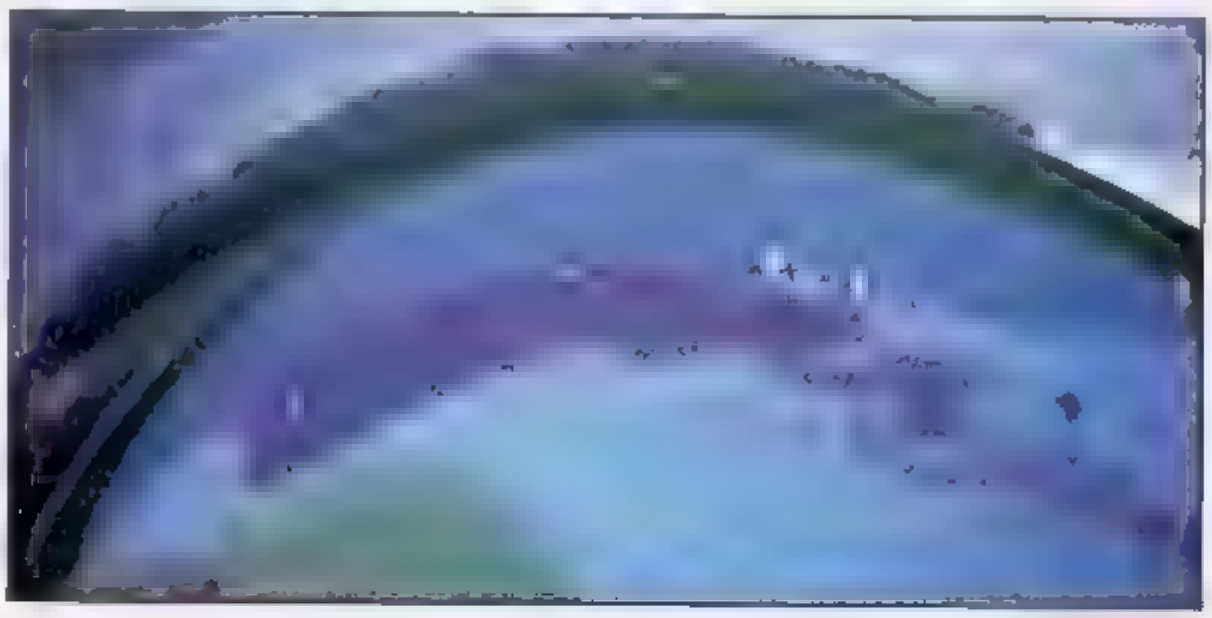
When fashioned into jewelry, it must be alloyed with other, harder metals in order to keep it from bending out of shape. It's also extremely heavy for its mass with a specific gravity of 19.3. But on the other hand, it has qualities that no other metal can equal. It is extremely ductile and malleable, one ounce of 24k gold can be stretched, without breaking, into a wire 50 miles long.

Gold is impervious to anything that nature can throw at it. It is a wonderful conductor of electricity. Many of the intricate electronic parts in our computers, television sets, and cell phones have contacts and connectors made of gold. It is used in astronauts' suits and face shields to repel harmful rays while in outer space. It is used as a sunscreen in windows without distorting the view from within. It has even been used as a very rare, decorative edible, although not digestable, desert topping in some restaurants. It can be buried in the ground and the sea for an interminable amount of time, yet upon recovery, it shows no significant sign of alteration. The only means of destroying gold, if one should desire such a disturbing and horrific achievement, is by using a mixture of sulfuric and hydrofluoric acids to dissolve it.

People in the know tell us that only a small fraction of the world's gold has been recovered to date. This means that there must be a tremendous amount still waiting out there somewhere for us to discover. All it takes is time, effort, the ability to identify gold-bearing stratum, and, I might add, luck to achieve this.

Advanced technology and methods of extracting and processing extremely low-grade gold ore have caused new mines to open and caused old mines in some areas to be re-opened. They are able to make a profit where previous mining methods failed. Yet, the gold in these deposits, for the most part, is quite often so minute and so sparse in quantity that it only shows up under high magnification. It takes several tons of ore to yield one ounce of gold. A case in point

On a recent field trip in Canada, I had the privilege of visiting a gold mine and processing plant at Snow Lake, Manitoba, where I witnessed a most interesting and educational gold pour (see "Destination Snow Lake," April 2003 *Rock & Gem*). During my visit, I was shown core samples of the ore body. To the naked eye, those cores looked like any ordinary rock, the gold was not visible. Yet, the company is able to produce several hundred ounces of gold per week from this worthless-looking rock.



I found gold! It was enough to sprinkle the bottom of a small glass bottle with pretty yellow flakes.

For recreational prospectors, attempting to recover gold from solid rock would be ridiculously out of the question. To experience any luck at all, we have to go where we can be reasonably sure that some native gold has been found in the past, an area where placer mining took place. As the old saying goes, "Gold is where you find it."

Nuggets this size can still be found with the right equipment, some hard work, and a lot of luck

Without a doubt, a great amount of surface and near-surface gold has been depleted throughout the world, particularly during the past two centuries. As an example, the Homestake Mine in South Dakota closed recently after an extremely long record of production. It was one of the richest gold-producing mines in this country, if not the richest. I'm certain that gold is still buried deep in that mountain near Lead, but it's too costly and labor intensive to recover.

After leaving Missoula I took U.S. Highway 93 north to Kalispell. From there, I drove northwest on U.S. Highway 2 to the Cabinet Mountains southwest of Libby. The scenery along these routes is spectacular, particularly in the Flathead Lake area.

When approaching Libby Creek from the south, some miles from the town of Libby, watch for and turn left on Forest Service Road #231, Bear Creek Road. It isn't all that hard to find, but if one isn't attentive, it can be easily passed by. Should you happen to arrive in the town of Libby, you'll know that you've gone too far.

The Recreational Gold Panning Area is 10 miles down secondary gravel Forest Road #231. The road is narrow and steep in places and meanders around and over some impressive hills, but it can handle heavy vehicles.

A very picturesque and quiet Forest Service (fee) campground is situated at Howard Lake another mile and a half past the panning area. Free camping is allowed at the recreation site. Toilets are provided on the premises, but we must carry our garbage out with us when we leave.

I spent two days at Howard Lake Campground. It's situated on the shore of this magnificent wilderness lake. While there, I drove the short distance to the panning site and spent several hours each day in my attempt to find that elusive yellow metal.

continued on next page

While sitting in the cab of my pickup, listening to the news, I had a panoramic view of Howard Lake. It was around noon when I noticed movement on the distant shore. Looking through my telephoto zoom lens, I saw a large cow moose feeding in the shallows across the lake from my campsite. Much of the time, only her head was above water as she fed on succulent water plants in the lake.

When I arrived at the Recreational Gold Panning Area early one morning and set up camp, I was prepared to do some serious mining. No one else was there. Occasionally, I heard heavy equipment a short distance away, repairing and upgrading Forest Road #231. The prospect of several more days of panning gave me the optimistic feeling that I should find some gold during this time. I hadn't done very well during the previous couple of days. I did manage to pan out several ounces of black sand, but if there was any gold in the pan, it certainly was minute. (Only hand tools and pans are allowed here, no sluices or dredges.)

Dirt dug from the hillside is panned in the nearby stream to recover the gold. Panners use chunks of firewood for seats.

The hours sped by as I worked in the stream. I didn't see anyone until late afternoon of my third day, when Ron Maupin came. As luck would have it, members of the Northwest Montana Gold Prospectors Club were to have a get together during the weekend. Ron was the first member to arrive, and he informed me of this event. He lives in Libby and came over after work to do a bit of panning.

The club holds title to several claims adjacent to the Recreational Gold Panning Area, but the claim area is rather mountainous, so they set up camp here where there's plenty of room and it's rather level. During my stay at the recreation site, I not only panned for gold, I did a bit of exploring. When following what must be an old, overgrown, one-lane logging road adjacent to the river, I came upon one of the club's signs. It indicated that beyond that point was a posted claim.

One morning while out taking photographs, I discovered remnants of a bygone era. Several sections of iron pipe and other bits of iron lay scattered about in a small clearing. These, I was told by NMGPC members, were part of a long pipeline that supplied water to the commercial miners' monitors. I would imagine the water was piped down from Howard Lake.

Another morning, upon being invited to inspect the club's claims, I followed a steep path up the mountainside to one of its digging areas. Along the way, right next to the trail, parts of a giant sluice lay scattered about. Even the spray bar, 10 inches in diameter, was lying next to the sluice. Bits and pieces of riffles were scattered about on the slope along with what appeared to be the remains of a building. (Antiquities law protects these items that are now a part of history and they may not be removed.) Being this high above the river, Howard Lake must have been the source of water.

Those remnants of the past represent the days when hydraulics was still considered a legal means of recovering large amounts of gold-bearing gravel. In the process, whole mountains were torn down by tremendous water pressure. Eventually, this method of mining was outlawed.

Here and there at the recreation area, evidence of that early method of mining is still quite prominent, with gigantic piles of boulders, some of tremendous size, heaped up here and there close to the road.

Ron asked me how I was doing, and I told him I had a large amount of black sand that I intended to take home and re-work, but no gold as yet. He asked if I'd tried panning other dirt besides the river gravel. My reply was negative. He pointed to an area and suggested I dig some of that dirt on the hillside. So, I took a 5-gallon pail, my folding shovel, an old hatchet that I use for this purpose, and a short gad, and went to work.

The gold-bearing dirt here is a mixture of very fine tan sand, the consistency of face powder, mixed with gravel and rocks of all sizes from marbles to boulders, in a very hard-packed, almost conglomerate situation. It's so hard that I had to actually hack at it with my hatchet and drive the gad into the bank and around the boulders in order to get a shovel full. (Eye protection is a must in this situation.)

Naturally, gold is much heavier than the surrounding material, yet this ground is so tightly packed my guess would be that the gold really has nowhere to go and cannot sink very far. It requires persistence and a bit of hard work to fill a 5-gallon pail.

I didn't have a classifier with me, so I had to remove all the larger rocks by hand. Anything smaller than a golf ball went into the pail. It took quite a bit of work to loosen the dirt from the embankment where I was digging, but I eventually had a bucketful and carried it across to the panning area. This shallow tributary of Libby Creek is right next to the camping area, and it's used by a half-dozen or more people at a time. Rubber boots or high-top overshoes are in order here. I wore my overshoes.

continued on next page

NWGPC member Estile Hunt's Idaho gold nugget is inspiration enough for anyone to get out there and try their hand at finding gold.

Montana Gold Panning *from page 67*

The NMGPC holds title to several posted claims adjacent to the Recreational Gold Panning Area

When we're ready to recover gold, a very important tool is a sniffer bottle, or gold guzzler. These are obtainable at any prospector supply store. Without it, you just cannot recover those tiny microdots (flakes) in the pan. Certainly, they're small, but they add up over time. A good pan is also essential. I prefer the plastic ones with the built-in riffles. I have an old "tin" pan that I bought some years ago while on a trip West. It probably was used by some prospector trying to make a living during the big depression of the 1930s. It still has some mercury clinging to it. I seldom use it anymore.

I washed several pans of dirt from that first 5-gallon bucket. After each reduction of material, I searched the pan for color. The first few pans held nothing in the tail that I could see. Then, I began to find tiny yellow specks in the pans that followed. The last pan yielded one larger grain of gold. Things were looking up.

With this incentive, I quickly returned to the embankment and filled another pail. It was getting toward lunchtime and more members of the club arrived. They treated me as one of their own, although I was a total stranger.

The second bucket went rather quickly and yielded nothing, but I now knew that gold actually was waiting to be collected from that mountainside. By this time, I was toughening up to the task, as I had already been working at it for three days. I took two pails to the diggings and eventually filled these, as well. Then, being tired and hungry, I quit for lunch. This gave me time to meet and get acquainted with some of the club members. I met several members while panning, including Maureen and Harry Pitman, Jon and Penny Van Dort, Estle Hunt; Milah Gano, editor of the club's newsletter, Gary Wilme, Jim and Cathy Osynd, and Clarence Taber, president.

Firewood lengths of logs positioned in the stream were used as seats while panning on a first come, first served basis. Attempting to pan for long periods while standing gets a bit tiring.

My days at the panning site were exciting and fruitful. I made it a habit to fill pails of dirt each evening, so that the next morning I could begin panning right after breakfast. I got so good at it that I filled three pails one evening. This kept me busy for most of the next morning.

In the evenings, I sat around the campfire with the members and had a most enjoyable time. By Saturday afternoon, the recreation site resembled a small village, with campers parked in almost every available space. Even a group of folks not connected with the club had set up their tents at one end of the camp. I have never seen a more courteous and friendly group of people anywhere. Everybody respected the quiet hour and I never heard any noise after 11 p.m. when I settled down in my camper bed.

I found gold! I didn't recover a lot, but I found enough to sprinkle the bottom of a small glass bottle with pretty yellow flakes. I even found a picker – a flake too large to be gazzled by my sniffer bottle. The evening before I left, I filled one more 5-gallon pail with dirt. I'll pan this when I get home.

It was still dark when I left camp and headed for home. Everyone was still sleeping. I had said my goodbyes the evening before. It was an experience that I shall not soon forget.

For more information on Libby Creek, write to Canoe Gulch Ranger Station, 12557 State Highway 37, Libby, MT 59923; call 406/293-8861; or visit www.libby.mt.com/area_attractions/libby_creek_gold.htm.

To learn more about the club, contact Northwest Montana Gold Prospectors Club, P.O. Box 3242, Columbia Falls, MT 59912, or visit www.mtmultipleuse.org/NWMGP/index.htm.

THE FRUGAL COLLECTOR

ARSENATES and VANADATES

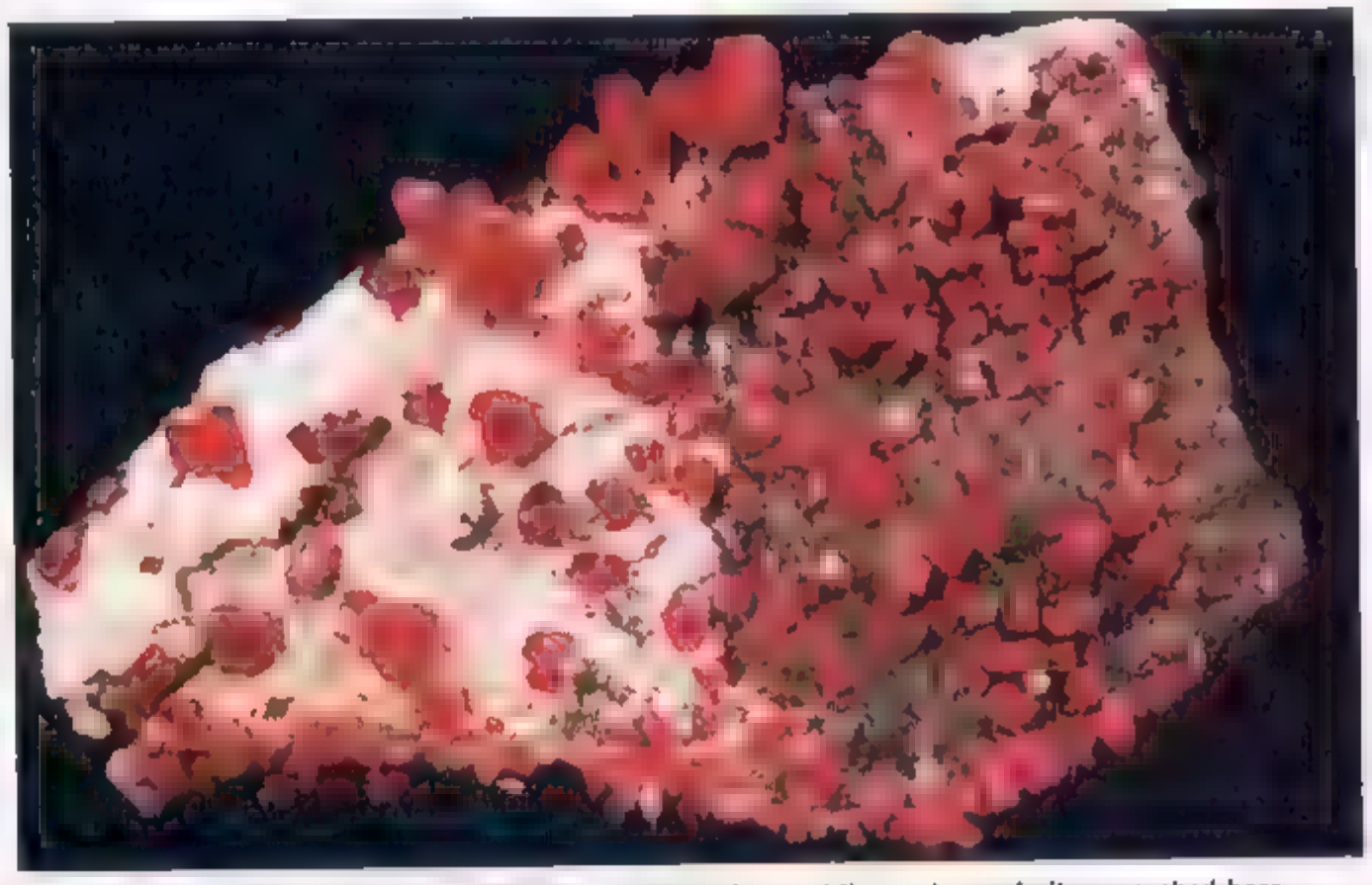
Part II: Descloisite, Mottramite and Vanadinite

Story and Photos by Bob Jones

The amazing thing about the metal element vanadium is that it is actually just as common in the earth as several other metals, including the well-known metals zinc and copper. Yet, you never hear of huge vanadium properties being developed. With so much vanadium around, there must a fair number of mineral species with the metal as part of their chemistry. In fact, there are something over 100 minerals containing vanadium in sufficient amounts to be listed as vanadium minerals. Ironically, in spite of this considerable number of species, probably only four or five vanadium species are common enough, safe enough, or attractive enough to be collected frequently and exhibited.

The reason for this has to do with the company vanadium keeps. It is a metal that loves to create mineral compounds with uranium. The result is a whole series of quite lovely, very colorful minerals that are common and would be exciting to collect, except the darned things are radioactive and are constantly decaying, giving off emanations like radon gas.

When I collected hobjonesite at the North Mesa #5 mine in Utah, which is in the heart of uranium country, I carried a scintillometer to keep track of radiation and wore a mask to limit the intake of dust underground. Naturally, dealers tend to avoid carrying such lovely species simply because of the radiation. And collectors seldom choose them and keep them for the very same reason.



The Apache Mine has been Arizona's largest producer of fine red vanadinites, perched here on white calcite.

EVAN JONES COLLECTION

The Mammoth-St. Anthony Mine has produced large clusters of subparallel, hoppered vanadinite with little or no matrix.

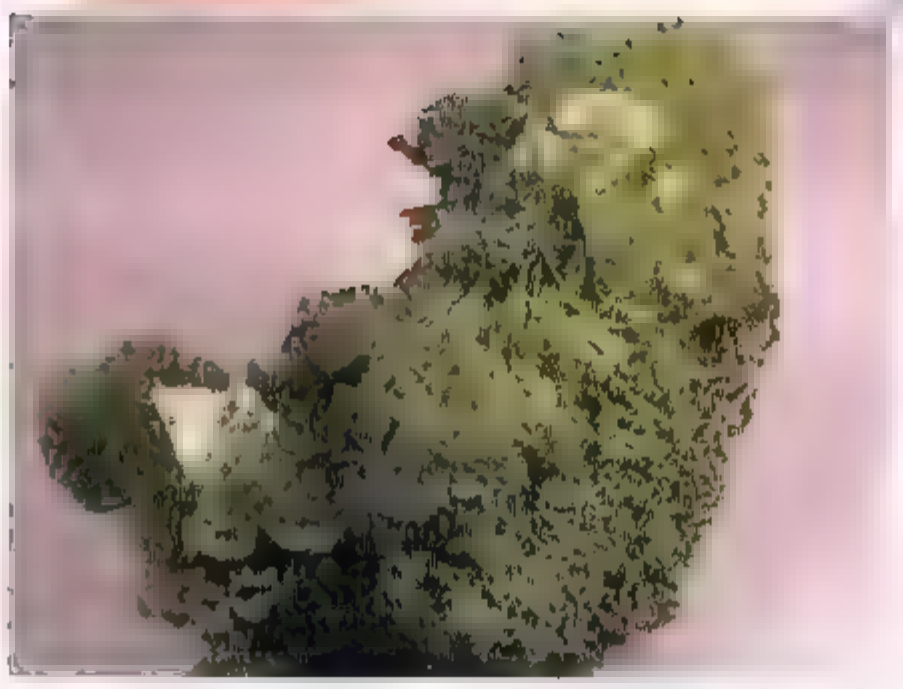
Some of the vanadium/uranium minerals are important ores for each of these metals. Carnotite, a potassium uranate, vanadate, is probably the most common radioactive mineral in the Four Corners area of the United States, a region rich in radioactive species. During the uranium boom of the 1950s, carnotite probably gave more prospectors heart palpitations than any other radioactive mineral. It will make a Geiger counter jump off the scale.

Huge deposits of this and other radioactive uranate/vanadate minerals were mined in the Four Corners area. Tyuyamunite (pronounced tie-yoo-yah-moon ite), another such compound, was probably the second most common radioactive mineral in the area. It was this region that made some prospectors, like Charlie Steen, millionaires when they staked rich deposits of radioactive minerals. At one time, Charlie had a marvelous mineral collection, but he lost it when the government sued him for back taxes.

These two yellow minerals, carnotite and tyuyamunite, sometimes invaded agate minerals like jasper and petrified wood, imparting a canary yellow color. These lapidary minerals make wonderful cabochons, book ends, and the like. The amount of radioactivity from the included minerals is minimal, so a lapidary can enjoy what a mineral collector cannot, as long as caution is used with the rock dust produced during lapidary work.

Minerals containing both the vanadate (VO_4) and uranate (UO_2) radicals are also found elsewhere. Without question, the oddest and most interesting deposit of radioactive minerals ever found is at the Mounana Mine, in the Western African country of Gabon. Scientists have identified a whole series of beautiful uranium and vanadium minerals here, including carnotite, vanuralite, chervetite, kasolite, carnotite, and francevillite.

What makes the Mounana Mine a most unusual deposit is what went on during its formation millions of years ago. It seems scientists are convinced that the amount of radioactive material in the original deposit, emplaced millions of years ago, was actually high enough and gave off enough natural radiation to actually trigger a low-yield natural atomic reaction. In other words, they think the deposit actually experienced a fissionable reaction, a natural atom a bomb, so to speak. This explains some of the unusual radioactive mineral species found there. There was a short period of time when the above-named species from the Mounana Mine were readily available, but once the deposit played out, they quickly disappeared, probably because of the radioactive factor.



This descloisite with cerussite from Tsumeb is an unusual green color.

You can see the problem with collecting vanadates. It sometimes keeps dangerous company, so the number of "safe" species limits the variety of vanadium minerals you can collect. But take heart. Not all vanadium minerals are radioactive. A few common collector minerals are available that are based on vanadium not joined with the uranium radical. These include vanadinite, descloizite and mottramite, along with a variety of vanadinite we used to call endlichite, but which is now considered simply an arsenian vanadinite. Though a discredited mineral name now, endlichite will still show up on specimen labels, and I see nothing wrong with that. After all, old habits die hard!

The metal vanadium, unlike copper, does not occur freely in nature. It is far too chemically active to stay unattached for long. In fact, the discovery of this very useful metal element came along rather late because it was so hard to distinguish chemically. It took decades to reveal itself, even after its existence had been suggested.

Vanadium is one of the few elements to have been identified first in the Western Hemisphere, thanks to Andres Manuel del Rio, Professor of Mineralogy at the School of Mines in Mexico City, Mexico. Del Rio was head of the Mexican School of Mines, he had studied at the schools of mines at Schemnitz and at Freiberg, the leading mineralogy and metallurgy schools in the world at that time. He was assigned to be professor at the School of Mines in Mexico City when it was established in 1795.

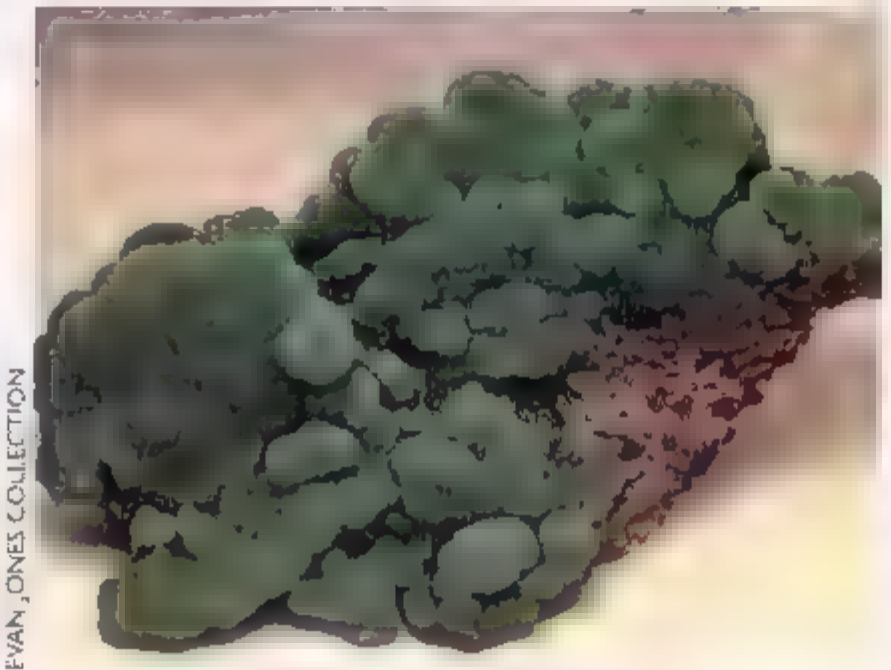
His investigations on vanadium started in 1801, when he was given an unknown brown mineral from Zimapan, Hidalgo. He thought the mineral contained a new element similar to uranium and chromium. Gradually, he extracted a final compound of the metal from its natural source and, because its salts were a lovely red, decided to call his new mineral erythronium. He was unable to extract the metal itself from those red salts, but he concluded he had isolated a compound of a new metal element.

As he continued to study the new compound, he came to the opinion that he was wrong, that the red compound was actually nothing new but simply another form of chromium. Chromium minerals, like crocoite, are sometimes red, so it is easy to see how he could be misled.

The new metal element, still not isolated, was put aside as a form of chromium until 1831, when it showed up during experiments on ores from a mine at Taberg, Sweden. Nils Gabriel Sefstrom, a professor at the Caroline Institute of Medicine and Surgery and at the School of Mines, Stockholm, found sufficient evidence to announce a new element. Again, he could not actually extract the metal from its red compound, but this was acceptable in those days.

Sefstrom called his new metal element vanadium, after the Scandinavian goddess Vanadis. Note that the suffix "ium" is used to denote an element. Sefstrom also realized that what he had discovered from the Taberg deposit was the same thing Del Rio had called erythronium.

The search for pure vanadium metal took further decades and the skills of a half-dozen scientists working on the vanadium compounds at hand. Several noted scientists of the time, Frederich Wohler, Jons Jakob Berzelius, and Henry Roscoe, were involved in the search. In 1865, Roscoe finally separated the metal vanadium from its compounds, so he was actually the first person to ever see the shiny silvery metal we now mix with iron to make a tough steel.



EVAN JONES COLLECTION

When arsenic gets into descloisite, the color changes to green and we call it arsendescloisite.

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It's no wonder that scientists had a problem extracting vanadium metal from its compounds. Vanadium, element number 23, is one of the more active transition metal elements. Metals form compounds based on their electron valence, so metals with variable electron arrangements are usually more chemically active than other elements. Vanadium has an extremely variable electron valence. It can be trivalent, tetravalent and even pentavalent, meaning that it can share or give up three, four, or even five of its electrons in a chemical reaction. This allows it to readily combine with a much wider variety of other elements and radicals than metals with only one valence. This explains, in part, the 100 or more vanadium minerals discovered so far.

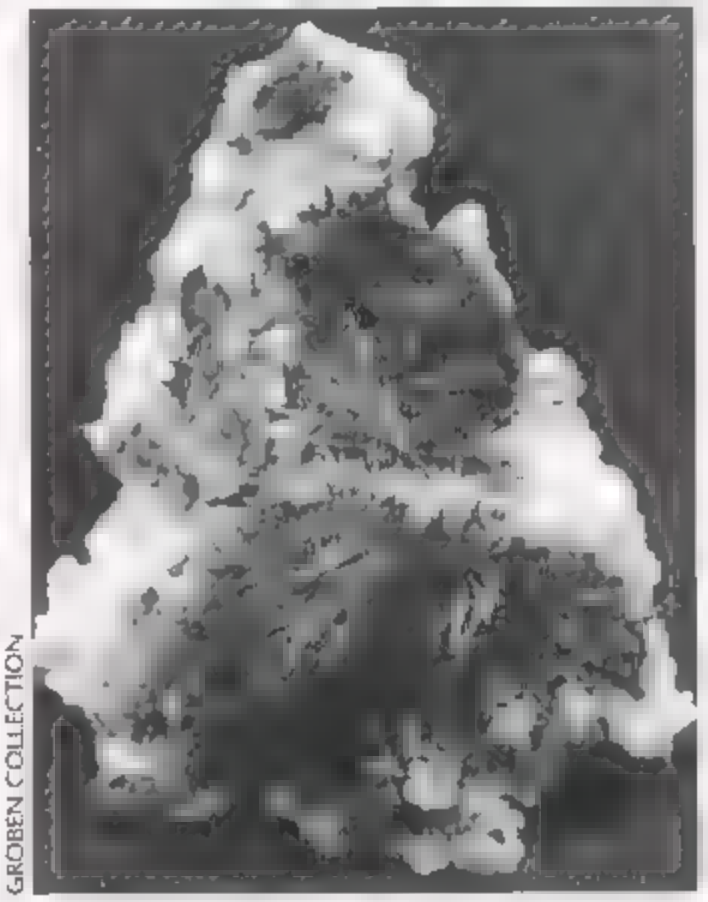
Most collectors will never see, never mind own, a specimen of the vast majority of vanadium minerals. The only vanadium minerals available in quantity for collectors, excluding anything radioactive, are descloisite, mottramite and vanadinite, and their varieties.

Descloisite and mottramite occur together in many deposits because they are chemical siblings, so to speak. Descloisite is a zinc, copper, lead vanadate, with the included elements listed in order of quantity. Mottramite, on the other hand, is a copper, zinc, lead vanadate. Note that the relative positions of the zinc and copper are interchanged as one exceeds the other in the particular mineral. The lead content remains constant. Since the vanadium and zinc radicals can readily substitute for each other in these compounds, they form a series. This means there can be a cuprian descloisite and a zincian mottramite and so on. Whenever both zinc and copper are present, the resulting lead vanadates, descloisite and mottramite, may both be found in the same deposit, and inevitably each will contain at least some trace of the opposite radical.

Descloisite is an orthorhombic mineral that forms tiny pyramidal, prismatic, discrete crystals, usually just a few millimeters long. It can also form drusy coatings or be stalactitic and even mammillary. To complicate matters, arsenic can also substitutes for one of the metals in the compound.

The color of descloisite is usually brownish to black-brown, but it can also be orange-red or deep reddish brown. Del Rio's mineral from Zimapan may well have been descloisite.

Color is one way you can distinguish between descloisite and mottramite, which is often grass green to olive green. Both minerals occur as secondary minerals in hydrothermal veins that have been oxidized or weathered. They are frequently associated with a variety of other secondary lead minerals like vanadinite, pyromorphite, cerussite, and mimetite. These secondary lead minerals almost always exceed descloisite and mottramite in quantity and appear. Since these other lead minerals can occur with either mottramite or descloisite, you cannot use the minerals associated with either to distinguish them.



GROBEN COLLECTION

Uranium/vanadium deposits often produce minerals like metahewettite, a hydrous calcium vanadate.

Perhaps the most spectacular occurrence of descloisite was at Djebel Mahsuer near Oudjha, Morocco. Brown descloisite has been found as a thick coating on huge vanadinite crystals, which can be as much as 5 inches long. The vanadinite, completely hidden by the brown descloisite, is a fair orange color and occurred as loose hexagonal crystals tapering to a rounded point.

Usually found as coatings or druses, descloisite and mottramite occur together at Abenab, Grootfontein and Tsumeb, in Namibia. All these localities are now closed, but specimens are still extant among dealer stocks. Katanga is a still-working source.

San Luis Potosi, which has several working mines, has produced a variety of descloisite rich in copper that is usually called cuprodescloisite. It tends to be green, which confuses identification with mottramite. In this country, Bisbee, Tombstone, and the Mammoth-St. Anthony Mine at Tiger, Arizona, have produced small quantities of brown descloisite.

Mottramite was originally found at an obscure locality, Mottram, St. Andrews, Cheshire, England. The finest specimens of this mineral are those from Tsumeb, where it occurred as lovely green discrete crystals to an inch or more. These have been highly prized by collectors who specialize in Tsumeb species.

The finest descloisite crystals are definitely from Grootfontein, Namibia, where an abundance of lovely mahogany-brown specimens with a very high luster occurred in tightly packed, spear-shaped clusters and groups. These were common in the 1970s. The crystals often exceed several inches by stacking one on another in parallel clusters. These were usually a lighter shade of brown at the tips. Other groups had crystals in rounded, flowerlike clusters, again to an inch or more. The Grootfontein crystal groups can still be seen at shows, though the last time I was at Grootfontein, the shafts were closed and the workmen's houses were derelict and abandoned.

Without question, the showiest vanadium mineral is the one whose name comes from the name of the element, vanadinite. Vanadinite is usually bright red, though the more prismatic hexagonal crystals tend to be orange on the edges. This reminds me of a rather distressing story. When I came to Arizona, despite having a master's degree in science, I was required to take some classes for Arizona teacher certification. One elective class I chose was mineralogy. The professor who taught the course was among the oldest on campus at the time.

While I was enrolled in that class, I often went to the Apache Mine, which was known all over the world for fine red vanadinite crystals in simple hexagons completely covering brecciated matrix. I gathered specimens with rather large dark-red vanadinite crystals that shaded to orange on the hoppered edges. I took a good specimen to college, intending to give it to the old prof for all his hard work teaching me.

I decided not to donate it when he looked at the specimen and informed me that the orange color meant that the crystal was more likely wulfenite. Now wulfenite one of my favorite minerals, forms in flat, tabular, tetragonal crystals, as opposed to vanadinite's typical simple hexagons. Wulfenite is a lead molybdate, a far cry from a lead vanadate. The Apache Mine was worked as a source of vanadium ore and never produced a single wulfenite. Incidentally, the Apache Mine, while being worked commercially, never shipped any rock, only tons of loose, bright-red, hexagonal crystals of vanadinite as ore that had been milled off the rock or simply gathered as it poured forth from open veins. Quen!

The Apache Mine is just one of the more prolific vanadinite sources in Arizona. A partial list of these sources sounds like a roll call of abandoned mines: Apache, Old Yuma, J.C. Holmes, Tiger, Grey Horse, Red Cloud, Rowley, Hamburg, Puzzler, Western Union, Rinaldo Pacheco, Castle Dome, and even Tombstone. Each of these mines produced significant, sometimes huge, amounts of fine vanadinite partly because, though closed, most have continued to be accessible to Arizona's mineral collectors.

In spite of the large number of sources, Arizona's vanadinite crystals seldom reached an inch in length. They have been eclipsed by specimens from Morocco. Morocco holds the record for the finest, most spectacular vanadinites. Its lead mines, particularly the Aouli Mine, near Mibladen, have produced wonderful specimens since the mid-1970s. Clusters of red hexagons on matrix were commonly found. Perhaps the more spectacular specimens are the red vanadinites on black mottramite, which provides a high contrast to the red crystals.

From Touissit come brilliant red simple hexagons that are sometimes hoppered. Usually in tight clusters that stack or rest against each other, the crystals can reach well over an inch. Many are nearly equidimensional, which gives them a thick and very attractive look. Another form of Aouli Mine vanadinite is the lovely tan to light-brown, slightly rounded prisms in clusters consisting entirely of interlocking crystals, no matrix. These crystals show the classic rounded barrel shape and many exceed an inch long. These are undoubtedly the arsenian variety of vanadinite.

Other vanadinite localities include Tsumeb, which produced a small number of fine crystal groups; the ancient silver mine at Laurium, Greece, several small lead mines in Cumbria, England, including Caldbeck Fells, and Les Farges, France, much better known for its superb green pyromorphite.

In Mexico, the original Zimapan locality yields nothing now. Choice crystals that easily exceed an inch and show a color gradation from brown to orange-brown have occasionally come from the Apex Mine, San Carlos. These are beautifully "capped" with small, snow-white, bladed calcite crystals.

Several mines in the Hillsboro and Lake Valley areas of New Mexico have produced superb arsenian vanadinite. The Puzzler is unusual in that it has yielded some very fine small, rounded hexagons colored olive green. Collectors mined these within the last 10 years, and they can still be seen for sale. The lovely color, a little unusual for vanadinite, is probably due to a little arsenic in the structure.

The J.C. Holmes property, just north of Patagonia, Arizona, is another mine that has produced vanadinite with a color other than red. The crystals are a very fine yellow-orange-tan color and show a dipyramidal form, distinctly different from the usual equant hexagons. The color is undoubtedly due to the arsenic content of the crystals.

On one field trip to the J.C. Holmes Mine, my collecting companion hit a superb narrow vein that produced some of the site's better crystals. The crystals approached an inch in length and are in tight pyramidal clusters. Small, cabinet-size specimens with crystals completely covering matrix were abundant in this find; choice thumbnail-size specimens were also extracted.

The Old Yuma Mine, now a part of the western section of Saguaro National Monument, produced some superb vanadinites. What I like about the mine was that it was very accessible, you could stand on the property and watch the traffic on Interstate 10 between Tucson and Phoenix. Old Yuma vanadinite crystals approach an inch and are often hoppered, and many of the larger crystals show that typical color change from red to orange near the termination. The finest specimens, lovely large crystals, occur on snow-white calcite, making a nice contrast. These specimens were found very near the surface in the workings of a small open pit. This same pit produced some of Old Yuma's finest orange-yellow wulfenite crystals.

Vanadinite from the Red Cloud Mine came out almost as an afterthought, since collectors were always more interested in hunting brilliant red wulfenites. Most Red Cloud vanadinites are mainly a druse of tiny crystals on a brown matrix.

If you want to see some spectacular specimens of vanadinite from the Grey Horse Mine, you'll have to go to the world famous Arizona Sonora Desert Museum. In the earth science section of the museum are some in situ displays: a cave of Mexican gypsums, a Mexican wulfenite pocket, a Bisbee velvet malachite pocket, and a Grey Horse Mine vanadinite pocket, all in a walk through mine replica. The wulfenite is from the San Francisco Mine, Mexico. The malachite was traded out of the American Museum of Natural History and was probably collected in the late 1800s. The gypsum (variety selenite) crystals are from the Cave of the Candles in Mexico. The vanadinites are interesting, as crystals completely cover large blocks of wall rock extracted intact by collectors.

continued on next page

Arsenates and Vanadates *from page 75*

While I really enjoy bright-red vanadinite specimens and consider them souvenirs of my most successful collecting trips, I find myself enjoying the resinous mahogany-colored vanadinites we used to call endlichite. My favorite endlichites are those from the Erapeion Mine, Los Lamentos, near Villa Ahumada, Chihuahua, Mexico. The village is on the main highway between El Paso and Chihuahua City, while the mine is some 45 kilometers east of the town.

Los Lamentos has been a marvelous specimen source. The best-known species from here are the pseudocubic bright-orange wulfenites on snow-white calcite, sometimes called onyx. The wulfenites often show a zoning with a darker center and brighter, more lustrous orange outer surface. Vast quantities of this sturdy wulfenite have been mined here and can be seen in collections, dealers' stocks, and many museums. If the water table at the mine ever drops significantly, you might see more of these beauties come to light.

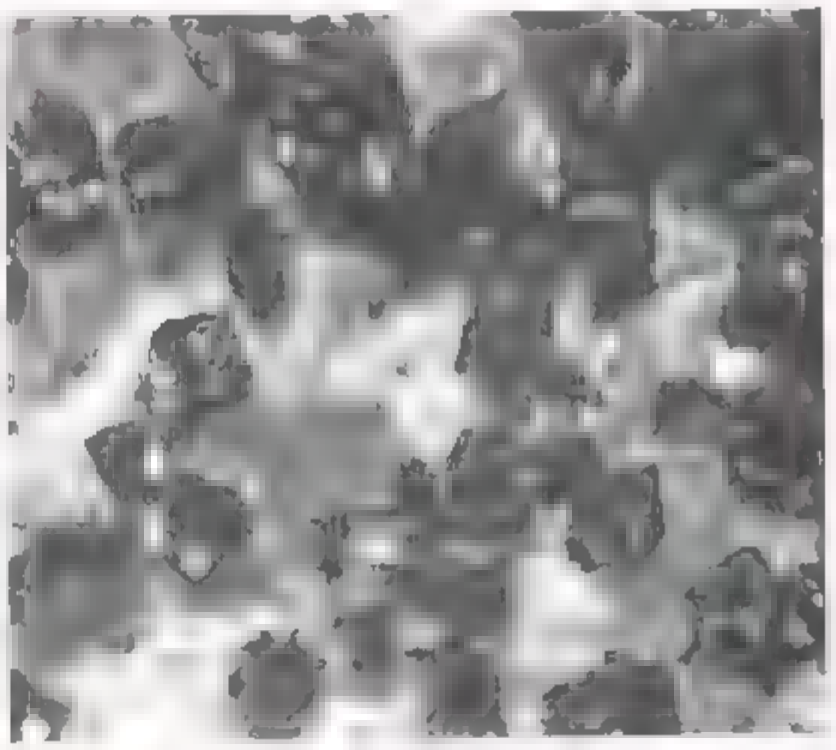
Years ago, after seeing and buying dozens of Los Lamentos wulfenites, I was fortunate enough to obtain one marvelous specimen, which won Best in Show for wulfenite at Tucson one year.

The endlichite from Los Lamentos is not as well known. Large quantities of this rich brown need-like vanadinite were mined here. Specimens range in size from a couple of inches to more than 6 inches across. The crystals are thickly clustered masses of sharp needles in diverging sprays with virtually no matrix. They are highly lustrous, and the color ranges from a dark brown at the base of the crystals to a lighter brown at the tips. They tend to be transparent, as well. Again, arsenic is the chromophore that causes the color in these lovely, though rather fragile, specimens.

For sheer color, the vanadinites from the Rinaldo Pacheco Mine are hard to equal. They are the most brilliant red color you'll ever see. This property is not far from the more famous Red Cloud Mine. The Pacheco Mine was lost for years, though rumors of its existence persisted for decades. It had been worked originally in the 1800s, worked sporadically, then lost. Several decades ago, one collector, in his wandering around the Red Cloud area, stumbled on some small dumps in which he found a few deep red vanadinites. Still, he did not realize their significance, and the mine was once again lost. Finally, a concerted effort by collectors found the mine and they worked it for specimens.

Nearby is the Hamburg Mine, another vanadinite and wulfenite property that yields brilliant red crystals of vanadinite. It has also produced some rather superb, small, bright red wulfenites not unlike those from the nearby Red Cloud Mine. It is interesting to note that the most brilliant red vanadinites and wulfenites occur in the region called the Silver District, which was developed in the 1800s for its silver. Tests on the bright-red wulfenites from the Red Cloud Mine show that chromium is the chromophore at work. Though no testing has been done, I have every reason to believe that chromium ions cause the same fiery red color in the wulfenites from the Hamburg property and certainly feel strongly that the vanadinites from the entire Red Cloud, Silver District area owe their bright red color to chromium, as well.

In spite of the very limited number of vanadate species available for collectors, the very prolific Arizona and Moroccan vanadinite sources have kept the market satisfied with fine red to tan crystals. As for mottramite and descloizite, they are no longer easy to come by and lack the spectacular color and appearance of vanadinite. There is no reason every collection shouldn't have one or more good examples of simple hexagonal vanadinite. The crystal form, bright color, and variety of occurrences should keep vanadinite in the fore of collector minerals for some time to come.



Mottramite, seldom seen in discrete crystals, is associated with red vanadinite from the Apache Mine.

Rock Science

Steve Voynick

Greenockite and Cadmium

From the visual standpoint, few collectors consider greenockite an especially attractive mineral. Greenockite crystallizes in the hexagonal system as tapering six-sided pyramids and hexagonal plates. Its color is yellow or orange with occasional brown, green or red shades. But its crystals are always small and occur most often as crusts or drusy coatings atop other minerals.

Nevertheless, greenockite does indeed interest collectors. That's because greenockite, which is cadmium sulfide, is the only significant mineral in which the element cadmium is an essential component.

Cadmium (Cd) is a bluish-white metal. Its specific gravity of 8.6 makes it about as dense as copper. Cadmium's physical properties are largely determined by the two tightly bound electrons in its outer shell. Because these electrons can bind only weakly to other cadmium atoms, the metal is so soft (Mohs 1 to 2) that it can be cut with a knife. Cadmium also has a low melting point of 610 degrees F, about the same as that of lead.

Although cadmium is about as abundant as silver, it forms few minerals. Cadmium occasionally occurs as a native metal and as several sulfides, a sulfate, a few arsenates, and an oxide, all of which are quite rare. Apart from greenockite, which is named for a locality at Greenock, Scotland, the only other cadmium mineral familiar to most collectors is otavite, a cadmium carbonate that forms white, trigonal crystals.

Cadmium has few minerals because of its strong chemical affinity for other metals, especially zinc, and to a lesser extent copper and lead. Cadmium substitutes readily for zinc within the lattice of the sphalerite (zinc sulfide) crystal. Most of the cadmium present in the Earth's crust is bound up in zinc minerals.

German chemist Friedrich Stromeyer identified cadmium as an element in 1817, after studying impurities in smithsonite (zinc carbonate) and incrustations in zinc-smelter furnaces. Cadmium's name derives from kadmeia, the ancient Greek word for calamine (later called smithsonite).

The important mineral forms of cadmium, limited essentially to the native metal and greenockite, are far too rare to serve as ores or to represent significant commercial sources of the metal. Nevertheless, some 20,000 metric tons of cadmium are "mined" each year. To be more precise, that is the amount of cadmium that is recovered annually as a byproduct of zinc, copper and lead smelting. Zinc smelting is the most important source of cadmium, with newly smelted zinc containing, on average, 0.3 percent cadmium.

For a metal with no ores of its own, cadmium has a wide variety of industrial uses. Sixty percent of all cadmium is used to electroplate anticorrosive coatings (similar to galvanized zinc coatings) on iron and steel. Cadmium, along with lead, tin and bismuth, is a key component of the low-melting-point alloys in automatic fire-sprinkler systems, fire alarms, and electric fuses. The metal is also a component of iron and silver solders, and its ability to readily absorb low-energy neutrons makes it an effective shielding material in nuclear-energy plants.

Cadmium is used in the manufacture of rubber, glass, porcelain, fluorescent paints, rechargeable nickel-cadmium and silver-cadmium batteries, and certain types of photovoltaic cells. The metal is also a component of the phosphors of black-and-white television screens and in the blue and green phosphors of color television screens. Finally, cadmium sulfide which is synthetic greenockite, is an important pigment known as "cadmium yellow" and the ingredient that provides the gold-orange color in fireworks.

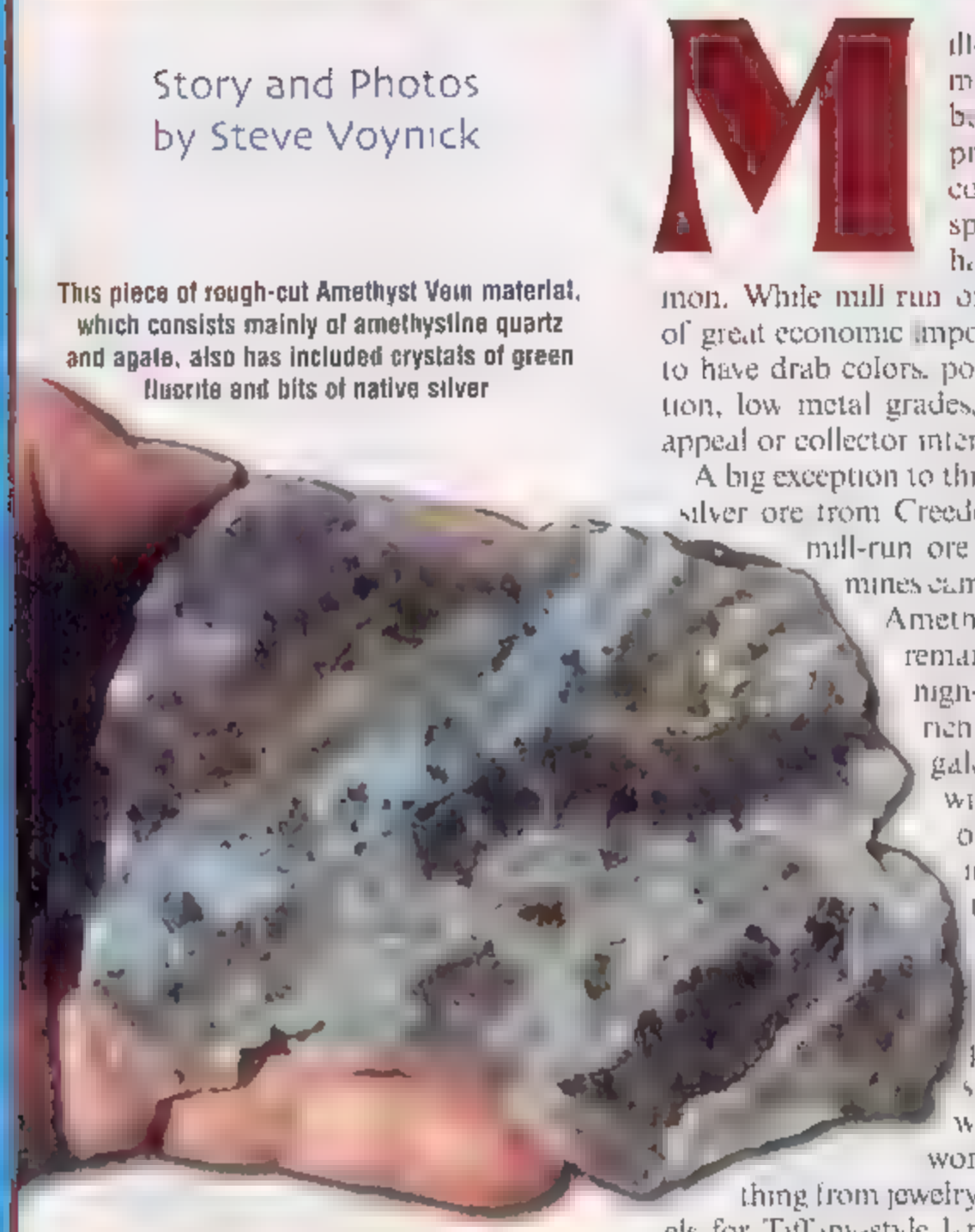
Despite its many uses, cadmium dust and the solutions and vapors of cadmium compounds are highly toxic. Cadmium is a cumulative poison that primarily affects industrial workers who are subjected to long-term exposure to the metal or its compounds. The symptoms of cadmium poisoning and mercury poisoning are similar. Because of its toxicity, cadmium uses are gradually being reduced.

A bit of background information about cadmium makes our greenockite specimens more interesting. It also explains why most greenockite specimens are composites with greenockite crusts atop other minerals, notably the zinc minerals sphalerite and smithsonite.

Colorado's Last Chance Mine

Rockhounds Get Another Chance to Collect Amethyst Vein Ore

Story and Photos
by Steve Voynick



This piece of rough-cut Amethyst Vein material, which consists mainly of amethystine quartz and agate, also has included crystals of green fluorite and bits of native silver

Mill-run ores, which make up the vast bulk of all mine production, and collectible mineral specimens usually have little in common. While mill run ores are obviously of great economic importance, they tend to have drab colors, poor crystal formation, low metal grades, and little visual appeal or collector interest.

A big exception to this rule, however, is silver ore from Creede, Colorado. The mill-run ore of many Creede mines came from the famed Amethyst Vein, a remarkable deposit of high-grade silver ore rich in argentite and galena and flecked with gleaming bits of native silver all in a matrix of pastel-colored, banded agate and purple amethyst. It makes fine display specimens, slabs and polishes well, and can be worked into everything from jewelry pendants to panels for Tiffany-style lampshades. Simply stated, Creede's Amethyst Vein ore may be the most distinctive and beautiful mill run ore ever mined.

Production from the underground mines that once worked the Amethyst Vein ended some 50 years ago. Since then, these privately owned properties have been closed to the public and Amethyst Vein specimens and lapidary material have become increasingly scarce. But that changed when rockhounds and mining history buffs Jack and Kim Morris recently reopened the Last Chance Mine as a fee-collecting site. The Last Chance, one of Creede's richest and most historic mines, dates back 115 years to the early days of Creede's great silver boom. Today, the mine is again a source of Amethyst Vein material for collectors and lapidaries.

Creede's was the last chapter written in Colorado's colorful silver-mining history. By 1881, the state's other silver camps, including Georgetown, Leadville, Aspen, Ouray, and Silverton, were already booming. But because of Creede's remote location in southwestern Colorado's rugged San Juan Mountains, its silver deposits went unnoticed for another decade.

Credit for the discovery goes to prospector Nicholas Creede. After finding an outcropped quartz vein with rich lead-silver mineralization in 1889, Creede and his partners staked the Holy Moses Lode.

This 20-pound specimen of rough-cut sowbelly agate from the Amethyst Vein shows delicate banding and subtle shades of purple.

The following year, other prospectors rushed in to make similar strikes along linear trends that followed long, continuous vein-type deposits. Three of these veins were named the Solomon-Moses, Mammoth, and Alpha-Corsair. The largest was named after its abundance of distinctive purple crystalline and microcrystalline quartz: the Amethyst Vein.

The story of the Last Chance begins with the last major strike in the Creede area. In 1890, prospector Theodore Renniger had unsuccessfully searched the area north of Creede. Feeling down on his luck, Renniger was about to give up. But when businessmen Ralph Granger and Erick Von Buddenbrock grubstaked him with $25 and three burros, the prospector decided to give it one more try.

Knowing that this was his last chance to strike it rich, Renniger began searching Creede's steep ridges and rugged rhyolite canyons in August 1891. Things went wrong from the start; his burros wandered off, and when he finally caught up with them high on the side of Bachelor Ridge, the stubborn animals refused to budge. Frustrated and weary, Renniger simply decided to prospect right where he was.

This time, luck was with him. Chipping away at a nearby rock formation, he uncovered a weathered outcrop of lead-silver mineralization in amethyst quartz that marked a northwestern extension of the Amethyst Vein. Renniger gave his discovery an appropriate name, the Last Chance.

Renniger quietly asked Nicholas Creede to assess his strike. Stunned by its richness, Creede urged Renniger to immediately delineate, stake and register his claims. Once Renniger had done this, Creede quickly staked the adjacent lower ground and named his claim the Amethyst Lode.

Mine development along the vein systems proceeded quickly, with the Creede district shipping its first silver—380,000 troy ounces—in 1891. When the Last Chance and Amethyst mines began production the following year, the district's silver output jumped to 2.4 million troy ounces. And in 1893, it doubled to 4.8 million troy ounces (about 150 metric tons), worth some $6 million.

By then, Ralph Granger had bought out the interests of Renniger and Von Buddenbrock for $150,000 to become the sole owner of the Last Chance. The mine would remain in the Granger family for more than a century.

Ryan Morris holds a slabbed piece of "center ore," consisting of nearly pure argentiferous galena, argentite, and native silver.

Ironically, Creede's emergence as a major silver producer coincided with the silver-market crash of 1893. At that time, western silver mines, notably those in Idaho and Colorado, were producing thousands of tons of silver each year, far more than the silver market could absorb. Yet, silver prices remained high for one reason: The Sherman Silver Purchase Act of 1890 required the U.S. Treasury to annually purchase huge quantities of the metal, even though it was not needed for coinage. By supporting the price of silver, this act kept hundreds of western silver mines in business. When Congress bowed to public pressure in 1893 and repealed the act, silver prices plummeted, and western silver mines closed by the hundreds.

But in Creede, extraordinarily high-grade ores more than compensated for depressed silver prices. Creede's mines, including the Last Chance, worked right through the silver-market crash and continued to earn big profits, thanks to Amethyst Vein ore that sometimes contained more than 2,000 troy ounces of silver per ton.

The origin of the Amethyst Vein can be traced back some 65 million years to the the Laramide Orogeny, when basement rock in what is now central Colorado uplifted to create the modern Rocky Mountains. In the process, this massive uplift also stretched and weakened the Earth's crust in southwestern Colorado, eventually making it unable to contain deep magmatic pressures.

Some 40 million years ago, magma finally penetrated the weakened crust in a long sequence of intense volcanic activity to form the San Juan Mountains. Enormous quantities of rhyolitic lava extruded onto the surface in three major volcanic phases. Following each phase, decreased magmatic pressure caused the surface to subside and fault. In the Creede area, this sequence of geologic events created a complex, highly faulted caldera, or collapsed volcanic system.

Later, deep magmatic pressures forced solutions rich in silica, lead, zinc, and silver upward into the caldera's fractured rhyolite country rock. During repetitive hydrothermal events, these solutions subsequently altered and mineralized the rhyolite, cementing fractured rhyolite into breccia and filling fissures and fractures with chalcedony, banded agate, amethystine quartz, native silver, and sulfides of lead, silver and zinc. These mineralized veins ranged in size from "hairline" fissure fillings to massive emplacements like the Amethyst Vein, which was as thick as 15 feet in places. Surrounding the Amethyst Vein were zones of associated lead-silver mineralization in altered rhyolite as wide as 100 feet.

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Amethystine quartz, colored by trace amounts of manganese oxide, sits atop a ribbon of sowbelly agate in this Last Chance Mine specimen.

Colorado's Last Chance Mine *from page 81*

Although the structure of the Amethyst Vein varies considerably, it is generally similar to that of a geode. The outermost vein section, which contacts the fracture walls of altered rhyolite, typically consists of dark quartz rich in argentiferous galena. Next is a delicately banded layer of white or bluish chalcedony, followed by another layer of dark, mineralized quartz. After that comes amethystine quartz, which is colored purple by trace amounts of manganese oxide. This amethystine quartz, which makes up roughly half the total weight of the vein, often has included crystals of argentiferous galena and green fluorite, along with bits of native silver.

Farther into the Amethyst Vein js an intergrowth of white crystalline quartz combs. Finally, in the vein's vuglike center, space permitting, are drusy growths of clear quartz crystals. In some vein sections, the center vug is filled with nearly pure, solid masses of argentiferous galena, argentite, and native silver. Because of its great density, a ton of this "center ore" has a volume of just 5 cubic feet, yet contains thousands of dollars worth of silver.

Parts of the Amethyst Vein consist of composite geode sections with multiple vugs, all surrounded by delicate patterns of banded fortification agate called "sowbelly" agate. Even in the 1890s, when few miners cared about the visual appeal of minerals, Creede miners recognized the beauty of Amethyst Vein sowbelly agate and often saved the most attractive material for lapidaries to slab and polish.

The Last Chance was blessed with a wealth of Amethyst Vein ore. Part of the Last Chance & New York Mining & Milling Co., the mine, with its 75 employees, immediately became one of Creede's top producers. Its 1,400-foot-long inclined shaft eventually served 13 underground levels. The sixth level, called the "Chance Six," worked a 100-foot-wide ore body, one of the widest sections of the entire four-mile-long Amethyst Vein.

The Last Chance Mine operated continuously under unified management from 1891 until 1947. The Granger family, which still owned the property, then leased mine sections to individual teams of miners until production finally ended in the 1960s.

During the 1970s, when silver became a free-market commodity, its sharply rising price refocused attention on many western silver mines. At the Last Chance, contractors started "mining" the surface dumps and shipping large amounts of ore to distant mills. Some of that dump material, considered low-grade by Creede standards of the 1890s, contained 38 troy ounces of silver per ton!

The 1970s also saw the final underground exploration at the Last Chance. Although silver reserves still existed, the high costs of modern underground development and environmental compliance made it economically unfeasible to reopen the mine. So the Last Chance was closed and largely forgotten for the next 20 years, its surface buildings slowly collapsing and its story becoming lost in time.

Meanwhile, silver production finally ended in the Creede Mining District in 1985 with the closing of its last mine, the Homestake Mining Co.'s Bulldog Mine (not on the Amethyst Vein). By then, Creede's cumulative production had topped 50 million troy ounces of silver and 100,000 tons of lead.

The Last Chance would likely have become just another forgotten Creede mine had it not been for Jack Morris. A Missouri native, Morris became interested in mining and minerals via an unusual route. As a professional trucker, he had hauled heavy equipment to mines in Missouri's lead belt and Arizona's copper belt, where he met many miners and began collecting minerals. In 1995, to further his interest in minerals and mining, Morris began spending his month-long annual vacations in Creede.

Of all the historic Creede mines, the Last Chance most intrigued Morris. The then owner of the Last Chance was Nancy Granger Schallen, the granddaughter of Ralph Granger, one of the businessmen who had grubstaked Theodore Renniger's successful 1891 prospecting trip. Over the years, Granger had passed sole ownership of the mine to his son Paul, who eventually passed it on to his daughter Nancy.

When Morris contacted Granger Schallen to learn more about the Last Chance, she asked if he wanted to buy the mine. After thinking it over, Morris replied that, yes, he was interested, but he couldn't afford it.

When asked why he wanted the mine, Morris explained that he planned to open it to the public, generate revenue from the sale of the Amethyst Vein dump material, then use that money to restore mine buildings and preserve the mine's history. Hearing that, Granger Schallen offered to sell Morris the Last Chance for nothing more than its assessed tax value.

Morris purchased the mine in 1997. Three years later, he moved to Creede and, along with his wife, Kim, began full-time restoration of three mine buildings. In 2002, they opened the Last Chance Mine as a fee-collecting site and historic attraction.

Admission to the Last Chance is free, and whether visitors collect or not, all will hear an account of the mine's history. The restored mine buildings rest on a flat area midway between the steep upper and lower mine-waste dumps, overlooking Willow Creek and the Amethyst Mine ruins 800 feet below. The collecting area is a level section of the upper dump accessed by a timbered walkway. Collectors who don't have their own equipment are provided with a bucket, rock hammer, and plastic spray bottle filled with water, the latter to assist in identifying Amethyst Vein rock. The charge to take material from the mine dump is $2 per pound.

Morris guarantees that collectors will find all the Amethyst Vein material they want. Most collect—and carefully select—between 10 and 40 pounds. Some take small bits for tumbling, while others select cabinet-sized specimens for display or even larger pieces for lapidary purposes. The largest single piece of Amethyst Vein material collected was a 300-pound boulder destined to become a yard display.

Sowbelly agate makes a superb cutting material, and serious lapidaries sometimes collect more than 100 pounds of it at a time. Collectors may also find fragmented plates of crystalline amethyst that formed as vug linings. Amethyst crystals as large as 1 inch have a clean purple hue and are sometimes gem quality. For those who do not wish to collect, the Last Chance sells a large selection of sowbelly agate, plate amethyst, and other rocks and minerals. Dump minerals include specimens of argentiferous galena and argentite that sometimes assay as high as 30 troy ounces of silver per ton.

Turquoise is another mineral occasionally found on the dumps. The Last Chance, along with mines at Leadville, Cripple Creek, Manassas, and Bonanza, is one of five Colorado turquoise sources. Although turquoise is not abundant, miners have collected it at the Last Chance since the 1890s. It occurs in a broad range of colors from yellow-green "lemon" turquoise to pale and deep greens and blues. Last Chance turquoise is sometimes flecked with iron-based brown inclusions and manganese-based black inclusions.

During the summer season, some 15 to 20 rockhounds and mining-history buffs visit the mine daily. Morris has also hosted rock and gem clubs from Colorado, New Mexico, and as far away as Tennessee. The family-oriented Last Chance Mine welcomes children over 6 years of age, provided they are kept under close parental supervision for obvious safety reasons. The Last Chance also has cabin accommodations for up to 12 visitors, with water, wood and bedding provided. Use of the cabins is free, but donations are gratefully accepted to fund mine-restoration work.

The Last Chance Mine is located five miles north of Creede just off the south loop of the 17-mile-long Bachelor Historic Tour, a scenic mountain route that passes many famous Creede silver mines. The graded-gravel tour route, while steep in places, is suitable for highway vehicles.

The elevation of the Last Chance is 10,600 feet, high enough to be a consideration for some elderly visitors or for those in poor health. Morris suggests that anyone prone to altitude sickness acclimate at lower elevations for a few days before visiting the mine.

Because of heavy seasonal snowfall, the Last Chance is open only during the summer. The mine opens on Memorial Day weekend and closes sometime in October, depending upon autumn snow.

In the future, Jack and Kim Morris plan to establish the Nancy Granger Schallen Museum to display minerals, mining equipment, and artifacts from the Last Chance Mine and the early days of Creede. They will also recondition an old portal to provide public underground tours, and have already consulted with state mine inspectors about the required ventilation, communication, and lighting systems necessary for public-tour approval.

Creede is located about 125 road miles northeast of Durango and 300 miles southwest of Denver. From the town of South Fork on U.S. Highway 160, the main east-west route through southwestern Colorado, follow state Route 149 north for 21 miles to Creede.

To collect some of the most beautiful mill-run ore you'll ever see, visit the Last Chance Mine. Remember, when it comes to collecting Amethyst Vein specimens and lapidary material, the Last Chance may be your last chance.

For information about the Last Chance Mine, call Jack and Kim Morris at (719) 275-0896 or (719) 238-7959, write to them at 1234 S. 11th St., Canon City, CO 81212, or visit their Web site, www.lastchancemine.com.

The San Francisco Mine near Cucerpe, Mexico, produced some lovely pseudomorphs of mimetite after wulfenite, in which the paper-thin wulfenite blades were completely replaced by tiny orange balls of mimetite. In a few instances, there apparently were not enough mimetite balls to complete the replacement, so there are tiny gaps within the crystals or along the rough, incomplete edges of what the blades. Such pseudomorphs are exceptionally uncommon and highly prized by collectors in the Southwest. Another source of these mimetites after wulfenite is the Rowley Mine, southwest of Phoenix.

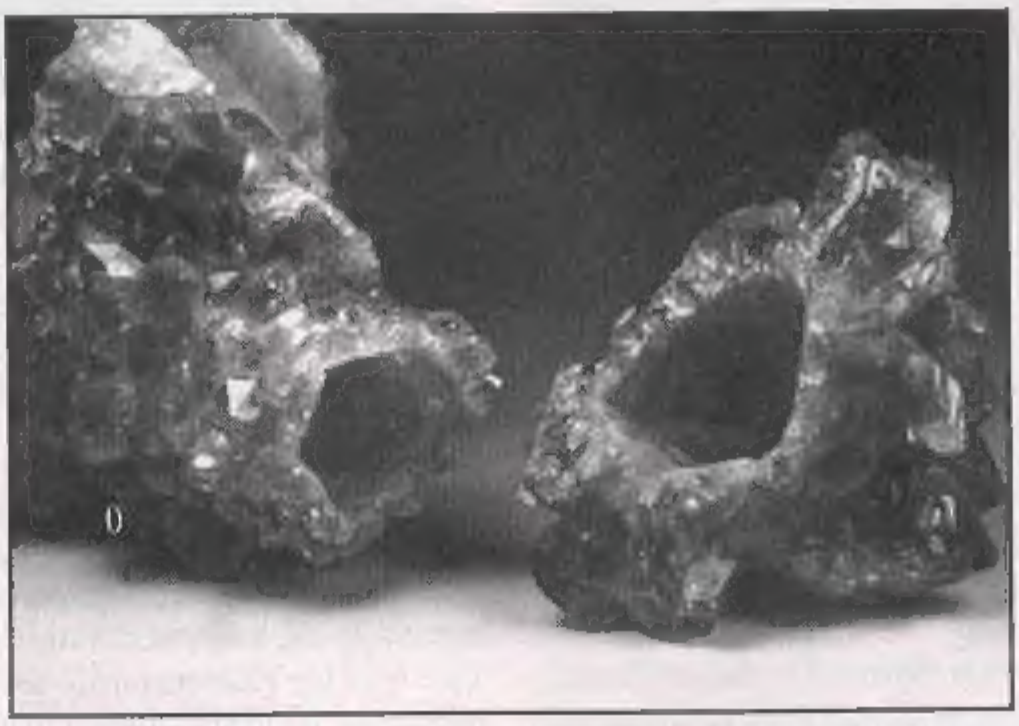
While metallic minerals commonly replace fossils, certainly the most exciting pseudomorphs are those fossils replaced by precious opal! Such valuable beauties are commonly found in the opal fields of Australia. The famous digs at White Cliffs, Andamooka, Lightning Ridge, and Coober Pedy have all yielded opalized fossils in abundance. While most precious opal fossils are relatively small, some huge specimens have been found!

The most valuable opalized fossil remains found in the Australian opal fields are those of the ancient plesiosaur that swam in the seas that once covered this land. Several of these skeletons have been completely replaced by rainbow opal. Most have been broken up and sold for gem rough, but one has been saved and is exhibited in a museum there. Rumor has it that an opalized plesiosaur will be the featured exhibit at the 2007 Tucson Gem & Mineral Show.

In reading Allen Eckert's excellent book *The World of Opals* (John Wiley & Sons, 1997), I came across one of the oddities of Australian opalized fossils. It seems in 1896, a miner's pet cat died. The man put the cat in his hat and buried it in the floor of his mine. Later, the mine was abandoned and not worked for 50 years. When another miner began working the diggings, he uncovered the buried cat in the hat. The surprise was that the cat's bony remains had been replaced by pink precious opal! Imagine, an opal after cat pseudomorph. If nothing else, that gives you some idea of how quickly some of the fossils may form. I strongly recommend Eckert's *The World of Opals*.

Of course, Australia does not produce the only opalized fossils. Opalized wood fossils are found in several places in the Western United States. They range from pink opal limb replacements to opalized pinecones. Nevada seems to be the major source of opal pseudomorphs and casts. Certainly, the opalized limbs and pinecones that are still being found after 100 years of mining in the Virgin Valley region of northern Nevada are extremely popular and are world famous, ranking among some of the most colorful opals ever mined.

Today, one of the more common fossil pseudomorphs seen for sale at shows is fossilized pinecones from Argentina.



Amethyst quartz crystals have formed a cast of the original quartz crystal. The original crystal was dissolved away.

These have been brought into the States in the last decade, primarily by Luis de los Santos, better known for his superb Argentinian Condor agates.

For the lapidary, one of the more popular fossil pseudomorphs is agate after dinosaur bone. In some areas of the Western United States, it is illegal to even pick up such items. So if you get a hankering for some good agatized dinosaur bone, you'd better check with area authorities were you plan to dig.

The wonderful thing about agatized dinosaur bone is the detailed cell patterns that are often perfectly preserved by the usually red agate cell fillings. The bones have a dull brown exterior, but when cut open, they reveal very nice yellow, tan, red, and brown agate cell fillings in a distinctive pattern that is quite attractive. As in petrified wood, the original structure has been invaded and filled by silica in the form of agate. The most exciting dinosaur bone replacement I've ever seen was a large leg bone that had been sliced across to reveal the solid agate interior. During fossilization, the soft tissue in the center of the bone was leached away, leaving a rounded hollow that filled with silica gel. This gel gradually developed into colorful banded fortification agate. So here we had a fine agatized dinosaur bone with a perfect fortification agate center. Quite a sight!

One of my favorite pseudomorphs, probably because of my interest in copper minerals, is native copper after aragonite crystals. Aragonite itself is often found in a pseudo form, in which six normally orthorhombic crystals of aragonite join to form a hexagonal or trilling form. Such pseudohexagonal twins are common in aragonite. Normally, when they are replaced by a mineral, that mineral is calcite. Good examples of this come from Las Animas, in Bent County, Colorado, which has produced some really fine calcites after aragonite. Much more spectacular and rare are aragonite trillings that have been replaced by native copper.

Superb copper pseudomorphs after aragonite trillings were found abundantly at a rich copper deposit at Corocoro, Bolivia. These are up to 2½ inches long, sharp, and in perfect six-sided form. The faces of these replacements are sometimes slightly concave, as the replacing copper atoms simply cannot occupy the same space as the original aragonite trilling form. Many are deformed or distorted, so a near-perfect specimen should be prized.

The Santa Rita copper pit in New Mexico has also produced some fine pseudohexagonal copper after aragonite crystals that are very popular, but not seen for sale much these days.

Copper is a common replacing mineral in copper mines. It has been found in the mines of Michigan's Upper Peninsula replacing fine cuprite cubes. The same have come from the prolific copper mines of Bisbee, Arizona, and the Santa Rita Pit, New Mexico.

Much less common than malachite after azurite are copper after azurite crystals. These occur in at least two copper mines in New Mexico, the huge Chino Pit and the less well-known Rose Mine, near San Lorenzo. Both these mines are in Grants County.

This brief summary of pseudomorphs hardly touches the possibilities for collecting this interesting mineral phenomenon. Collecting pseudomorphs is an interesting exercise in crystallographic and chemical studies. Experience the thrill of ferreting out the odd and unusual minerals in disguise that collectors often ignore.